National Aeronautics
and Space Administration

March 27, 1995
AO-95-OSS-02

Announcement of Opportunity

Medium-class Explorer Missions

(MIDEX)

Appendices

Notice of Intent Due: May 10, 1995 Proposals Due: June 27, 1995

APPENDIX A

The NASA Med-Lite Expendable Launch Vehicle

This Appendix presents data on the NASA Med-Lite Expendable Launch Vehicle (ELV), particularly those characteristics that either affect or constrain the payload. Proposed payloads must be compatible with the data contained in this Appendix.

1. LAUNCH VEHICLE DESCRIPTION

Med-Lite is currently in the procurement cycle. Since the actual launch vehicle(s) and Contractor have not been selected, the launch vehicle will be referred to as "Med-Lite" throughout this Appendix. The selected Contractor will use the Med-Lite ELV to provide launch services for the MIDEX missions to be selected and confirmed from proposals received in response to this AO. Med-Lite will be a multistage solid- or liquid-propellant vehicle, launched from a U.S. launch site.

The Med-Lite Contractor will use launch vehicles appropriate for the proposed payloads. Proposals responding to this AO are limited to missions that can be achieved within the capability of a vehicle from this mixed fleet. This constraint is appropriate for the fiscal, scientific, and technical scope of the MIDEX program. Moreover, limiting the required launch-vehicle performance also reduces the launch-vehicle cost to NASA.

2. PAYLOAD/VEHICLE INTEGRATION AND LAUNCH

Integration of the payload to the Med-Lite vehicle will be accomplished at the yet-to-be-determined U.S. launch site. The Med-Lite Contractor will manage the mission integration of the payload flight and ground systems with the launch vehicle and its associated ground support equipment (GSE).

3. PAYLOAD MASS

Separated payload mass capability for the Med-Lite service varies with orbit altitude, inclination, and fairing configuration. The Med-Lite RFP specifies performance

requirements for a number of missions, as shown in Table A-1. A parametric set of orbit performance curves will be available when the Med-Lite vehicle has been selected. Those proposers who have a question about a specific payload to a specific orbit may use the questionnaire in Figure A-3 at the back of this Appendix to determine feasibility.

4. ORBIT INJECTION ACCURACY

Orbit injection accuracies vary with the mission orbit. For low Earth circular orbits (<1000 km), the 3σ altitude errors are about ±10 km, and the 3σ inclination error is about ±0.04 degrees.

5. FAIRING ENVELOPE AND PAYLOAD ATTACH FITTINGS

The payload, consisting of the spacecraft and instrument(s), must fit within the static envelope of the Med-Lite vehicle. The vehicle selected for the Med-Lite service may offer several fairings. The performance requirements in Table A-1 are associated with the fairing sizes as defined in Figure A-1. Generally, the larger payload envelopes are required by higher mass payloads. For instance, a payload envelope configuration no larger than 3A, in Figure A-1, is specified for the 450 kg payload mass capability to a 500 km, 5 degree inclination orbit noted in Table A-1. For a given mission in Table A-1, the use of a larger fairing will reduce the mass capability and may be unacceptable for upper stage accommodation or vehicle stability reasons.

The standard mechanical interface specified in the Med-Lite RFP is a 985.77 mm (38.810 inch) bolt circle at the top of a payload attach/separation system provided by the vehicle. Since the mass of the payload attach fitting has already been factored into the capabilities of the launch vehicle, the total mass capabilities listed in Table A-1 are available for the payload.

6. ENVIRONMENTS

Environment specifications from the Med-Lite RFP are shown in Figure A-2.

7. ELECTRICAL INTERFACE

The electrical interface between the launch vehicle and the payload will provide a minimum of 42 pins. It will provide the capability for battery trickle charge and

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payload monitoring prior to launch, for passing a minimum of three discrete signals to the payload during flight, and for confirming separation.

8. SPIN

The Med-Lite vehicle will be capable of separating the payload in either a spinning or nonspinning mode. The Med-Lite RFP specifies that the vehicle shall provide a spin rate up to at least 15 rpm.

TABLE A-1 MED-LITE RFP PERFORMANCE REQUIREMENTS

Earth Orbit Missions	Perigee Alt (km)	Apogee Alt (km)	Inclination (deg)	Payload Mass (kg)	Fairing Configuration (Figure A-1)
1	800	800	25	1,360	1
2	600	600	75	450	4
3	870	870	98.9	1,397	1
4	500	500	5	450	3A
5	1,400	1,400	75	1,000	3
6	185	45,000	90	440	4
7	704	704	94	1,000	3
Earth Escape Missions	**Perigee Alt (km)**	**C_3 (km^2/sec^2)**	**Declination of Launch Asymptote (deg)**	**Payload Mass (kg)**	**Fairing Configuration (Figure A-1)**
8	185	11	Launch Date Dependent	450	2
9	185	20	<28.5	300	1A
10	185	0	<28.5	580	2

Notes:
1. Mission 6 has an argument of perigee requirement of 270°.
2. Escape missions require specific values of C_3, right ascension and declination of the launch asymptote for each day of the 20-day launch window. Parking orbit coast times for these missions may be up to a complete orbit period.
3. Fairings must accommodate payload static envelope diameters as specified in Figure A-1.
4. Payload mass does not include vehicle-provided attach hardware.
5. Altitudes specified are relative to the equatorial radius of the Earth.

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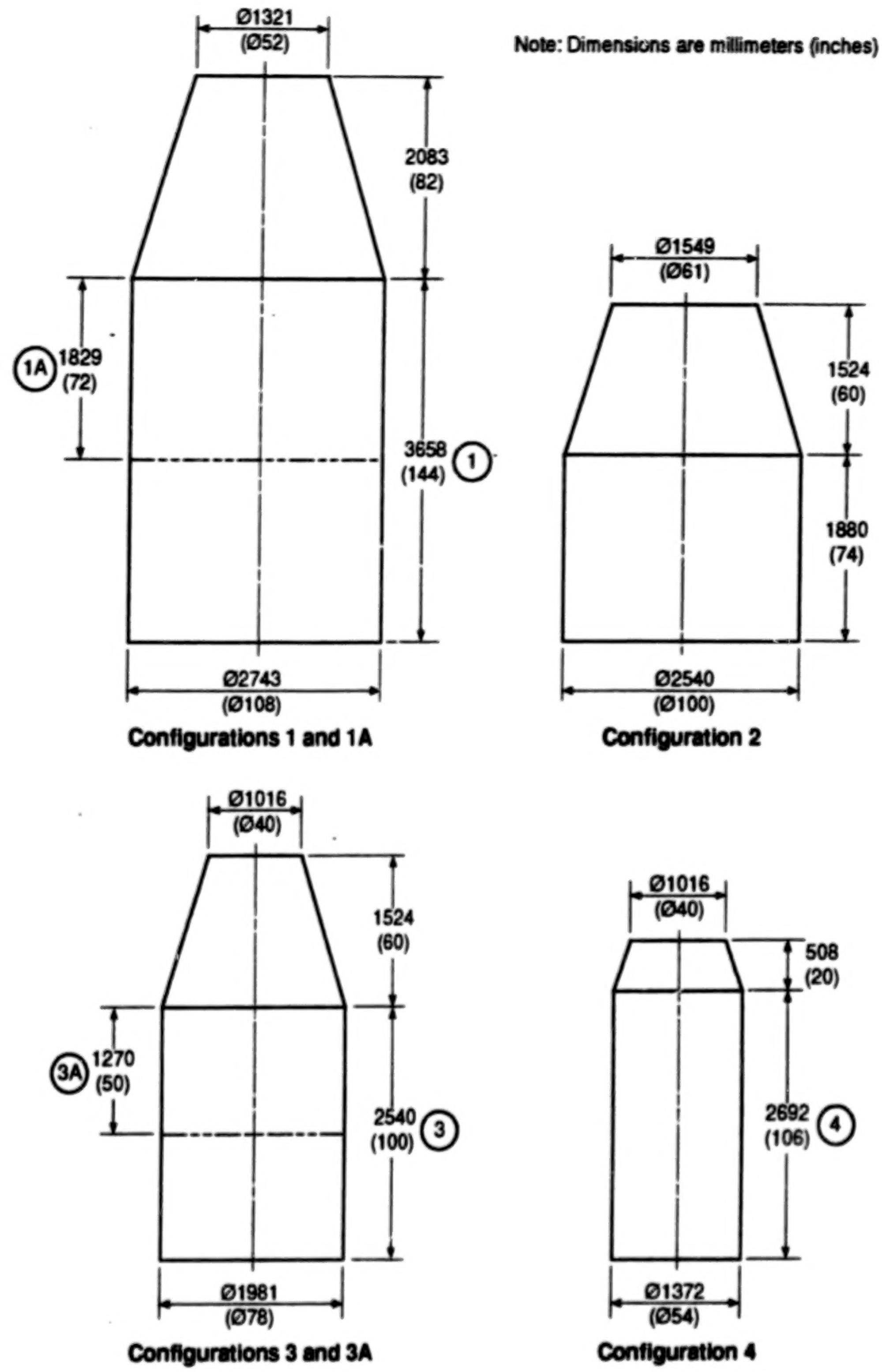
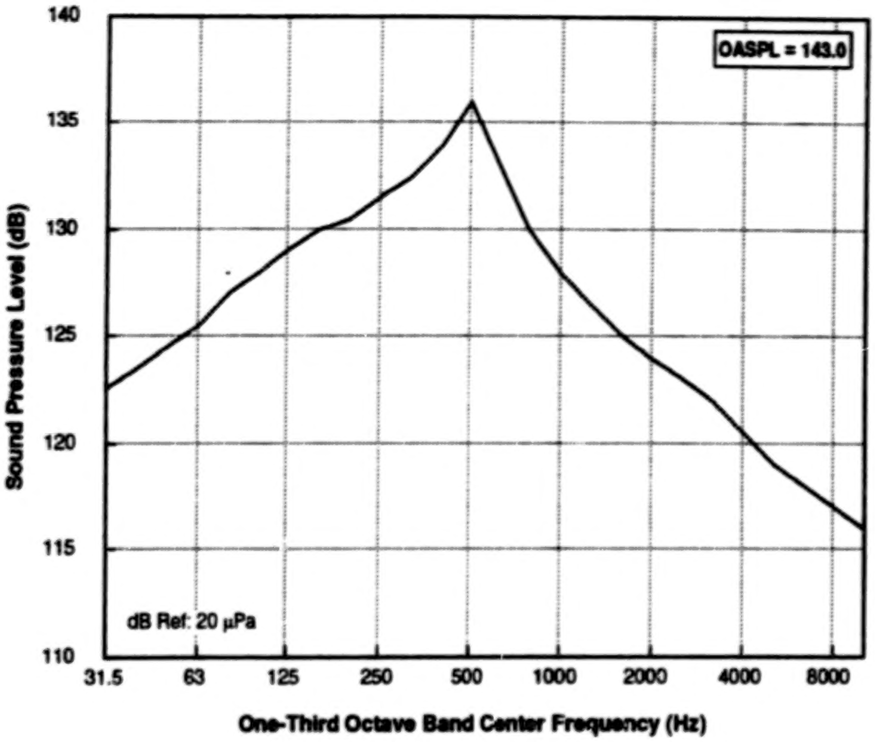
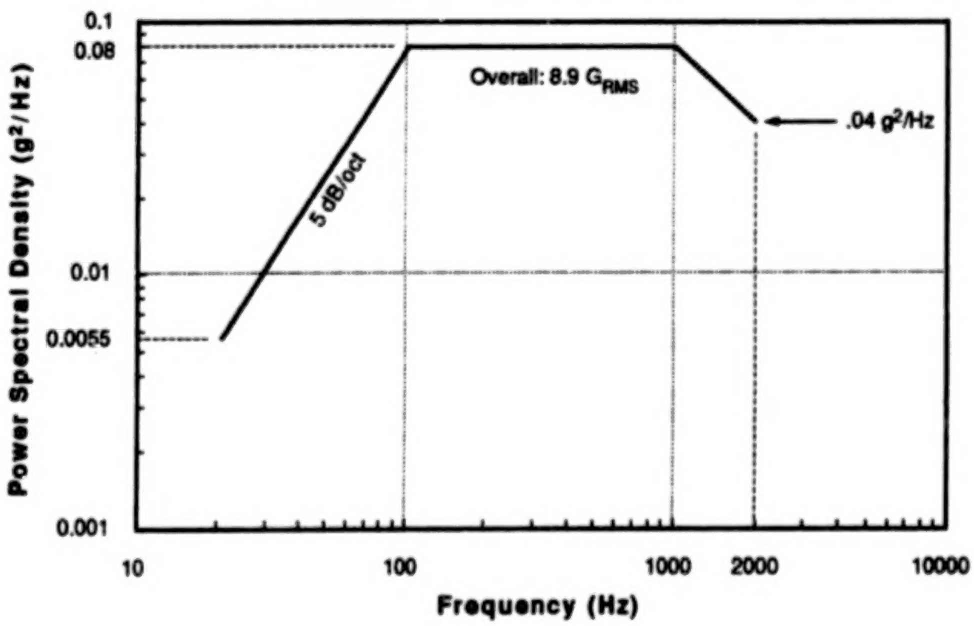


FIGURE A-1 FAIRING STATIC ENVELOPES SPECIFIED BY THE MED-LITE RFP



One-Third Octave Center Frequency (Hz)	Maximum Flight Levels (dB)
31.5	122.5
40	123.5
50	124.5
63	125.5
80	127.0
100	128.0
125	129.0
160	130.0
200	130.5
250	131.5
315	132.5
400	134.0
500	136.0
630	133.0
800	130.0
1000	128.0
1250	126.5
1600	125.0
2000	124.0
2500	123.0
3150	122.0
4000	120.5
5000	119.0
6300	118.0
8000	117.0
10000	116.0
OASPL	143.0

(a) Spacecraft Acoustic Environment - Maximum Flight Level



(b) Spacecraft Interface Random Vibration Environment

FIGURE A-2 MAXIMUM SPACECRAFT ENVIRONMENTS FOR THE MED-LITE VEHICLE

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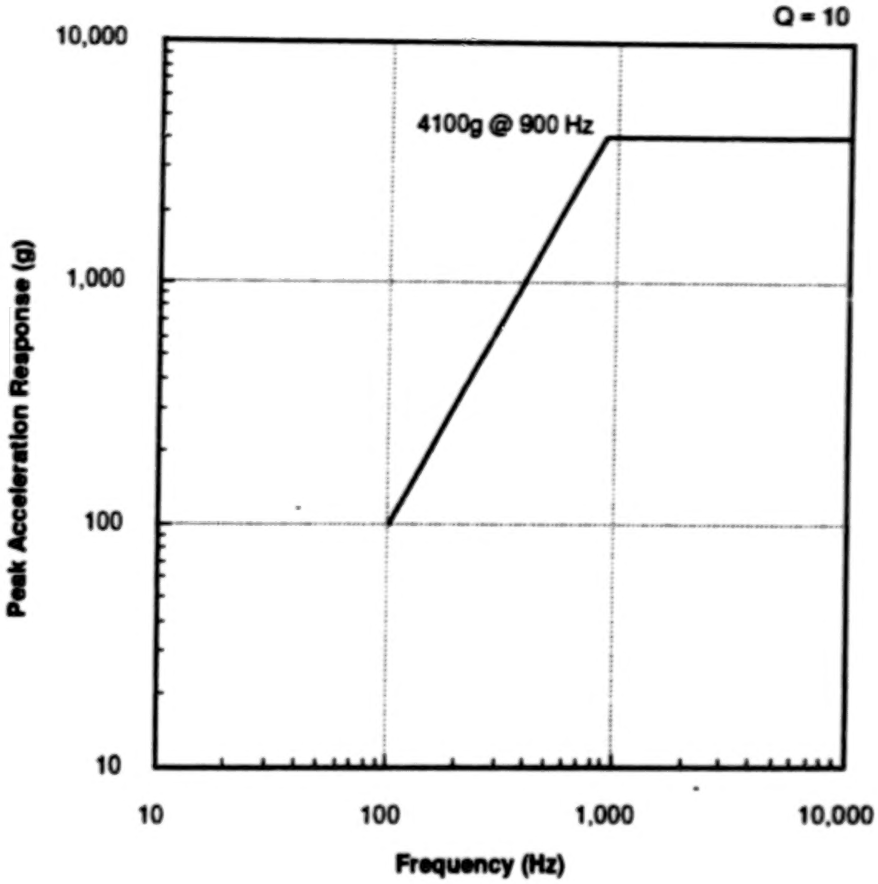

(c) Spacecraft Interface Shock Environment - Maximum Flight Levels

Axis	Acceleration (g's)
Max Axial	+11.0/−2.0
Max Lateral	± 3.5

Notes: Axial tension is designated with a negative sign.
Accelerations are simultaneous.

(d) Spacecraft Design CG Limit Load Factors

FIGURE A-2 (CONT.) MAXIMUM SPACECRAFT ENVIRONMENTS FOR THE MED-LITE VEHICLE

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Request for clarification of a specific payload to orbit

Provide the following information to determine if the mission orbit is achievable.

Apogee (km)	______________
Perigee (km)	______________
Inclination (deg)	______________
C_3 (km^2/sec^2)	______________
Argument of Perigee (deg)	______________
Payload Mass (kg)	______________
Fairing Configuration	______________

Send the above information to the following:

Name: Mr. Bruce Milam

FAX: (301) 344-4925

E-Mail: Bruce_Milam@ccmail.gsfc.nasa.gov

FIGURE A-3 PAYLOAD QUESTIONNAIRE

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APPENDIX B

The NASA-Provided Medium Explorer Spacecraft

1. OVERVIEW

The intent of this Appendix is to define an envelope of NASA-provided spacecraft consistent with the allocation of budgets provided in this Announcement of Opportunity. The information provided is intended to simplify the task of the proposal team in developing a spacecraft concept for use in their proposal and to ensure that the proposed investigation lies within the bounds of the MIDEX program. The capabilities here apply to NASA-provided spacecraft designed, built, integrated, and tested at GSFC as well as those procured by NASA. It does not apply to spacecraft provided by the PI in the PI-Mode.

The detailed information presented here is based heavily on the component heritage developed in the Small Explorer (SMEX) program. It is intended as a common reference basis for the proposers and evaluators. The proposed spacecraft concept should be used to demonstrate mission feasibility, but should not be regarded as a final design. Should the proposer desire, it is acceptable to substitute a different set of components such as those in an existing industry spacecraft. In order to establish the credibility of a concept derived in this manner, the heritage and reference basis of the concept must be described in sufficient detail to allow GSFC to determine the probable cost of (and the cost risk associated with) the proposed spacecraft concept.

The proposal requirement is to determine the basic spacecraft concept and overall system architecture that meet the scientific requirements and to show mission feasibility. This is accomplished by choosing the spacecraft resources from the data in Section 3 (or a suitably documented other source), performing a conceptual design and addressing the technical information requested in Appendix F. **Requests for enhanced performance beyond the spacecraft baseline can usually be accommodated but must be included in the cost of the instrument (capped at $40M) for proposal purposes.** During mission definition, system trades will be performed to

determine the most cost effective means of implementing the selected investigation. This may result in a reallocation of funding between the instrument and spacecraft.

It should be recognized that a spacecraft concept generated with either the NASA in-house component set or that from industry does not represent a decision binding on NASA to implement the mission in that manner. GSFC will determine the spacecraft development mode within one month after selection.

Experience has shown that launch-vehicle constraints, fiscal constraints, and the wide variety of science objectives make a common multimission spacecraft impractical. Structures and attitude control systems are designed for the unique needs of each mission. Major subsystem elements, however, can be taken from an inventory of spacecraft subsystem designs that have been developed for other missions. These items include standard batteries, transponders, power systems, data handling systems, and instrument interfaces.

The baseline MIDEX spacecraft system architecture, described in Section 2 below, is versatile and high-performing with heritage from the Submillimeter Wave Astronomy Satellite (SWAS) mission, which is part of the Small Explorer (SMEX) program. The architecture is single-string and nonredundant with some degraded modes of operation possible due to the versatility and robustness of the system design. It is the intent of GSFC to conform to industry standards whenever possible in the development of MIDEX spacecraft.

Through the SMEX program, GSFC, in partnership with the investigator teams, has developed or is in the process of developing a variety of missions using the key elements of the baseline architecture. These missions represent the present thrust and hands-on knowledge base of the Center's small spacecraft missions. The Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX, in orbit since 1992), Submillimeter Wave Astronomy Satellite (SWAS, in flight integration and test phase), Transition Region and Coronal Explorer (TRACE, in detailed design phase) and Wide-Field Infrared Explorer (WIRE, in extended definition phase) missions are examples of these. The Fast Auroral Snapshot Explorer (FAST, fully qualified and validated for launch) mission required an alternative architecture driven by the limited power and mass resources available to the spacecraft, and by the harsh radiation environment of the FAST orbit.

Section 7 provides a description of the SWAS and FAST missions, while Table B-3 summarizes key characteristics of all five SMEX missions. This information is provided for reference and to illustrate the flexibility of the baseline spacecraft architecture and associated components.

2. BASELINE MEDIUM EXPLORER SPACECRAFT ARCHITECTURE

The baseline spacecraft architecture is illustrated in Figure B-1. Considered to be radiation tolerant, this spacecraft can be flown in all low Earth orbit environments. All systems use unregulated 28 volt power from the Power System Electronics (PSE). All systems communicate through a MIL-STD 1553 or 1773 data bus.

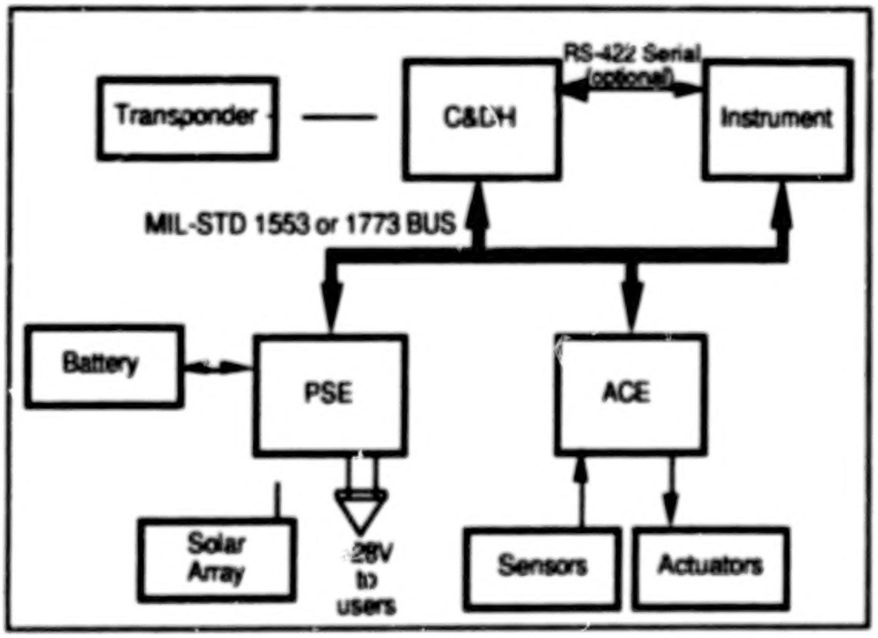

FIGURE B-1 BLOCK DIAGRAM OF THE BASELINE MIDEX SPACECRAFT ARCHITECTURE

A. Command and Data Handling System

The Command and Data Handling (C&DH) system controls all spacecraft operations, supports attitude control system computations, collects and stores telemetry, maintains time, processes commands, initiates deployment, and interfaces to the instrument.

The C&DH is based on a 386 class computer. The C&DH is capable of ingesting ground commands at 2.0 kilobits per second and of outputting telemetry at selectable rates up to 1.8 megabits per second. All telemetry is encoded to reduce errors. After

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accounting for the overhead of encoding, Consultative Committee on Space Data Systems (CCSDS), ground/space link communications protocol, and the bandwidth allocated to spacecraft telemetry, approximately 1.4 Mbps is available to the instrument.

Bulk data storage is accomplished using volatile, solid state random-access-memory devices with error detection and correction. The bulk memory is uniquely sized for each mission in order to limit size, mass, and cost. The baseline capacity for instrument data storage is approximately 80 Megabytes, limited by what can be downlinked in a ground station pass. Typically, only 60% of the pass duration can be allocated for telemetry downlink.

The C&DH operates with a time-division-multiplexed protocol. Each piece of instrument data read by the C&DH is marked with the time, with a resolution of 4.0 milliseconds prior to storage. More accurate timing resolution may be negotiated on a case by case basis during mission definition. Spacecraft time is maintained to better than 3 seconds absolute time.

B. Transponder

The Medium Explorer spacecraft uses a Ground Network (GN) compatible transponder. It operates in S-band and can support all C&DH data output rates. If required for orbit determination, the transponder can perform coherent Doppler reflection and range-tone broadcast. Tracking and Data Relay Satellite System (TDRSS) compatibility is not included in the baseline. However, mission trade studies will be performed during the definition phase to determine the technical feasibility and cost effectiveness of utilizing TDRSS.

C. Power System

The spacecraft power system design can support orbital average loads up to 240 watts at the end of two years. A NiCd type battery is used to power the spacecraft during the eclipse period of the orbit, with both 9A-Hr and 21A-Hr batteries available. Peak loads are limited to 1/2 of the selected battery rating, i.e., 4.5A for the 9A-Hr battery and 10.5A for the 21A-Hr battery. Unregulated 28V (+/-7) power is distributed to the subsystems. The baseline solar arrays are fixed flat wings with an area of ~6 m^2 and a temperature range of -80 to +90 degrees C. The arrays can deliver up to 240 watts orbital average (EOL) to the bus in a typical low Earth orbit, assuming 2/3 Sun and

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1/3 eclipse, when the normal to the plane of the arrays is within 5 degrees of the Sun line. Missions with longer eclipse periods or less favorable Sun angles would achieve a proportionally lower power output from the arrays. The spacecraft power allocation is 175 watts orbital average. Other batteries, alternate solar array configurations and arrays with higher watt densities are available. However, the cost of these enhancements must be included in the instrument budget.

D. Attitude Control and Determination

Attitude control is a mission unique system. The C&DH provides for the hosting of a digital attitude controller, which typically is incorporated for science pointing mode operations. This controller collects sensor data and issues actuator commands through the Attitude Control Electronics (ACE) box. The ACE serves as the hardware interface for the attitude control system (ACS) and is also used to provide a C&DH-independent safehold controller. The safehold controller is used for initial attitude acquisition and on-orbit emergencies. The baseline safehold will safe the spacecraft and maintain a power positive attitude, but will not provide any special instrument protection. Such protection must be accounted for in the instrument budget. The baseline system incorporates onboard attitude determination and orbit propagation. For a three-axis-stabilized platform, the baseline spacecraft is capable of providing sunline pointing accuracy of 2 arc-min per axis and 2 deg accuracy rotation about the sunline for most low Earth orbits. With the addition of attitude sensors beyond the baseline, such as a star tracker and an upgrade to an inertial grade gyro, pointing accuracy of 30 arc-secs, 3 axes is achievable. With the provision of a suitable fine error signal from the instrument, sub arc-second boresight accuracy is achievable. Precision sensors beyond the baseline capability must be costed in the instrument budget. Simpler missions, such as flown on SAMPEX, can be accommodated with a subset of the baseline sensors. ACS performance, including accuracy, stability, and knowledge, depends entirely on the hardware devices that are flown and the specific spacecraft and instrument characteristics. Therefore, ACS sensors and actuators should be chosen to support the specific requirements of each mission. The TRACE mission described in Table B-3 utilized a representative set of baseline sensors and actuators.

E. Thermal

Thermal designs are unique to each mission. Power limitations require primarily passive designs that rely on fixed radiators, blankets, thermostatically controlled heaters, and selective coatings. Instrument thermal control is an instrument function.

The baseline architecture assumes an instrument that is thermally isolated from the spacecraft as much as is practical.

F. Instrument Data Interface and Control

It is strongly recommended that the instrument contain its own controller to allow a decoupled interface with the spacecraft and facilitate testing and integration. The instrument/spacecraft data-system interface is via the MIL-STD 1553 or 1773 bus, which can accept science payload data rates of at least 50 kbps. Higher data rates, up to 900 kbps, can be accommodated using the high-speed RS-422 serial port to the C&DH.

3. RESOURCES OF THE NASA MEDIUM EXPLORER SPACECRAFT SYSTEMS

Proposers should use the spacecraft resources provided in this section to estimate the requirements of the Medium Explorer spacecraft systems as they apply to their specific proposals. Proposers must address each topic covered in paragraphs A through G, below. The data in this section have been derived from experience on previous missions. Proposers are required to discuss the rationale for deviations from these guidelines. Design margin is not included in these numbers. Unless otherwise noted, power is expressed as orbital average load.

	Mass Basis
A. Structural/Mechanical (percentage of maximum observatory mass to orbit)	20%
• This includes the following: primary structure (aluminum, traditional construction), miscellaneous bracketry and fasteners, balance weights (nonspinning spacecraft)	
B. Solar Array and Shunts	
• Solar arrays (includes shunt assemblies and harness)	7.3 kg/m^2

	Mass Basis
• Hinge/damper assemblies (deployed array)	1 kg/m^2

C. Battery

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• 9-amp-hour battery (11 cm x 18 cm x 30 cm)		11.3 kg
• 21-amp-hour battery (13 cm x 23 cm x 38 cm)		23.1 kg

D. Electrical

• Electrical harness (percentage of observatory dry mass)		6%
• Spacecraft umbilical assemblies		0.45 kg

E. Thermal

• Typical heater orbital average power consumption (percentage of total spacecraft orbital average power)		5%
• Battery radiator (15 cm x 25 cm)		1.4 kg
• Transponder heat sink		1.1 kg
• Thermal blankets (percentage of spacecraft dry mass)		1.5%

F. Avionics	Mass	Power
• Command and Data Handling — The size, mass, and power consumption of this assembly depends on the mission requirements. The basic box, which can support the ACS requirements of most missions, contains 80 Megabytes of bulk data storage for instrument telemetry. Storage for spacecraft telemetry and software has already been allocated in addition to these numbers. (30 cm x 28 cm x 23 cm)	12.0 kg	13.0 W
• Power System Electronics — Includes shunt drivers, if necessary (32 cm x 26 cm x 24 cm)	14.0 kg	10.0 W
• Transponder-5 W RF output (30 cm x 18 cm x 12 cm)	4.1 kg	
- Standby		4.5 W
- Transmitting		33.0 W

	Mass	Power
• 2 Fixed S-Band omni-directional antennas	1.5 kg	n/a

- Initiator box — This is only flown if initiators are required (i.e., to deploy solar arrays, booms, etc.). Each module, which operates six devices, occupies approximately 410 cm^3 and weighs approximately 0.68 kg.

G. Attitude Control System

The ACS support varies considerably from mission to mission. The following resource estimates are typical for hardware used in the first five SMEX missions.

- Attitude Control Electronics Box
  The basic box interfaces to the MIL-STD 1553 or 1773 bus, provides a hardware interface to the ACS sensors and actuators, drives electromagnetic torquers, and contains safehold circuitry.

  - ACE box (28.6 cm x 25.5 cm x 10 cm) 12.0 kg 6.0 W

- Resources required by baseline ACS devices are listed in Table B-1.

4. DESIGN MARGIN REQUIREMENTS

All proposals must contain margins of at least 20% mass and 20% orbital average power for the observatory. Larger mass margins are suggested for instruments that require significant development. The mass margin should be calculated as a fraction of the maximum observatory wet mass to orbit. The power margin should be calculated relative to the EOL (2 year) orbital average power generation capability.

5. INTEGRATION AND TEST AND GROUND SUPPORT EQUIPMENT

Depending on the implementation mode, the science instruments will be mechanically, electrically, and functionally integrated to the spacecraft using GSFC

TABLE B-1 BASELINE ACS DEVICE RESOURCES

Device	Component requirements		
	Size (cm)	Mass (kg)	Orbital Avg Pwr (W)
Reaction Wheel (per wheel)	(dia x ht)		
• 0.14 N-m, 2.80 N-m-s	20 x 10	4.3	10.0
• 0.175 N-m, 20 N-m-s	25.4 x 9	6.5	20.0
• Electronics box for three wheels	3.1 x 16.5 x 16.5	2.3	included in above power
Electromagnetic Torquer (per bar)	(dia x ht)		
• 30 kilopole-cm	2.3 x 49.5	0.73	5.5
• 60 kilopole-cm	2.8 x 66.0	1.8	5.5
• 130 kilopole-cm	2.3 x 85	2.1	3.7
• 170 kilopole-cm	3.9 x 94	5.0	1.42
Gyro (3 axis)	28 x 17 x 17	4.9	24.0
Digital Sun Sensor (1 arc-min accuracy)			
• Sensor	11 x 8.5 x 3	0.32	in elect.
• Electronics	14.5 x 12.5 x 8	1.13	2.0
Coarse Sun Sensor	Negligible	0.05	N/A
3-Axis Magnetometer (0.5 deg accuracy)			
• Sensor	11.5 x 11.5 x 11.5	0.3	in elect.
• Electronics	7.6 x 17.5 x 17.5	1.8	1.7

facilities or contractor provided facilities. Following this and prior to launch, the combined spacecraft/instrument system will be thoroughly tested to verify its performance. Instrument operational, safe-to-mate and test procedures are the responsibility of the investigator. During integration and testing, a local area network (LAN) to the spacecraft integration and test ground support equipment (GSE) will be

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the interface to the instrument GSE. The instrument GSE must recognize and process instrument data over the LAN using the LAN's communications interface protocol. GSFC will provide a test conductor to control spacecraft operations during integration and testing activities.

6. ORBIT SELECTION GUIDELINES

Orbit selection is driven by many factors including science requirements, orbit lifetime, ground station coverage, and radiation concerns, including sensitivity to trapped radiation in the South Atlantic Anomaly.

A. Ground station coverage

In order to reduce mission operations costs, the spacecraft must operate autonomously for long periods of time. It must store the science data onboard, and quickly transmit the data to the ground station when a station pass occurs. The average pass duration for a low Earth orbit is only 8-10 minutes, depending on orbit altitude and inclination. Typically, only 60% of the pass duration can be allocated for telemetry downlink. High inclination orbits are recommended because the longest period between passes is reduced, minimizing the bulk memory requirements and the required downlink time.

B. Attitude controllability

Missions that require three-axis stabilization cannot adequately manage momentum build-up with only magnetic torquers in near equatorial orbits. To avoid costly gas-reaction control systems, mid- to high-inclination orbits are recommended for missions that require three-axis pointing, if compatible with science objectives.

C. Radiation

Normal design practices, such as those used by GSFC on the spacecraft described in this Appendix, typically result in a minimum effective aluminum shielding thickness of 2.5 mm (0.1 inches), and will, therefore, accommodate the radiation tolerance capabilities outlined in Table B-2. The FAST implementation, in addition to satisfying low weight and power limitations, was designed to operate in a harsher radiation environment than SWAS and the other SMEX missions.

TABLE B-2 RADIATION TOLERANCE

	Dose Capability at the Part-Level (krads Si)	Orbit Capability (2 yr. mission life)		
		|i| < 60	|i| > 60	Other
Baseline Architecture	5	O.K.	Analysis Required*	Analysis Required*
FAST Implementation	30	O.K.	O.K.	Analysis Required*

* Analysis required to consider effective shielding, mission duration, specific orbit environment, solar cycle, etc. Proposers with radiation questions about a specific orbit may use the questionnaire in Figure B-13 to obtain information.

7. SMALL EXPLORER MISSION IMPLEMENTATIONS

The MIDEX spacecraft capability is based on SMEX heritage. The SMEX mission designs have distinct configurations, which were uniquely tailored (particularly the FAST mission) to meet the requirements of the missions. The key characteristics of all five SMEX missions are summarized in Table B-3. The SWAS and FAST spacecraft designs are briefly described in the following paragraphs.

A. SWAS Spacecraft Design

Schematics of the SWAS instrument and spacecraft payload, both assembled and as subsystems, are shown in Figures B-2 and B-3.

The SWAS is a three-axis-stabilized, stellar-pointed spacecraft with a pointing accuracy of 38 arc-sec and jitter less than 19 arc-sec. The spacecraft will, typically, point the science instrument at 3-5 targets per orbit. Target selection is constrained such that the solar arrays always face within ±15 degrees of the Sun, except during eclipse. The Principal Investigator will generate the observation timeline and select the guide stars. The spacecraft will "nod" from an on-source target position to an off-source target position up to three degrees away in less than 15 seconds. This nodding occurs approximately every 40 seconds. Attitude control, including pointing and nodding, are accomplished by using three magnetic-torquer coils, one digital sun sensor, five coarse sun sensors, three momentum wheels, one magnetometer, three inertial gyros, and a high accuracy Charge Coupled Device (CCD) star tracker. The ACS uses the spacecraft computer to perform closed loop attitude determination and control.

TABLE B-3 CHARACTERISTICS OF SMEX MISSIONS

Item	SWAS	FAST	SAMPEX	WIRE	TRACE
Launch Vehicle	Pegasus XL	Pegasus XL	Scout	Pegasus XL	Pegasus XL
Mission Life	up to 2 years	1 year	3 years	4 months	1 year
Nominal Orbit	600 km circular 65°	350 x 4,200 km 83°	550 x 675 km 82°	400 km circular 97.2° sun sync	700 km circular 98.2° sun sync
Redundancy	single string	single string	single string	single string	single string
Mass (kg)	252	180	157	294	224
Instrument	71	51	40	88	50
Spacecraft	181	129	117	206	174
Power Allocation - orbit avg (W)					
Instrument	59	15	22	45	35 + 30 heaters
Spacecraft	133	33	60	170	170
C&DH					
Spacecraft Processor	dual 32-bit, 386/387	dual 8-bit 80C85	32-bit, 386/387	32-bit, 386/387	32-bit, 386/387
Data Bus	1553	1553/RS-422	1773	1553/RS-422	1553/RS-422
Science Data Rate (kbps)	12 (avg)	science data processed on board[1]	3 (avg)	8 (avg)	50 (avg)
Instrument Mass Storage	70 Megabytes	1 gigabit (on instr)	26 Megabytes	80 Megabytes	80 Megabytes
Command Uploads	1/day, 17 kbytes (avg)	1/day, 11 kbytes (avg)	1/day, 2 kbytes (avg)	1/day, 35 kbytes (avg)	1/day, 1 kbyte (avg)
RF Communications					
Telemetry (Mbps)	1.8	0.9/1.5/2.25	0.9	1.8	1.8
Command (kbps)	2	2	2	2	2
Antennas	1 directional (micropatch)	1 high gain directional (micropatch)	2 omnis	2 omnis	2 omnis
Transponder	Std NASA S-band	Std NASA S-band	Std NASA S-band	Std NASA S-band	Std NASA S-band

1 Solid state recorder part of the instrument data processing unit

TABLE B-3 (CONT.) CHARACTERISTICS OF SMEX MISSIONS

Item	SWAS	FAST	SAMPEX	WIRE	TRACE
Attitude Control Type Pointing Accuracy Pointing Stability ACS Components	3 axis stabilized 38 arc-sec[2] 19 arc-sec 3 torquer rods 1 DSS 5 CSS 3 reaction wheels 1 magnetometer 3 gyros 1 high accuracy CCD star tracker	spin stabilized 1 deg (knowledge)[3] N/A 2 torquer rods 1 spinning sun sensor 1 horizon crossing indicator 1 magnetometer	momentum biased 2 deg N/A 3 torquer rods 1 2-axis DSS 5 CSS 1 reaction wheel 1 3-axis magnetometer	3 axis stabilized 60 arc-sec(1σ) 12 arc-sec (2σ) 3 torquer rods 1 DSS 5 CSS 3 reaction wheels 1 magnetometer 3 gyros 1 high accuracy CCD star tracker	3 axis stabilized 20 arc-sec[4] 0.1 arc-sec[5] 3 torquer rods 1 DSS 6 CSS 3 reaction wheels 1 magnetometer 2 gyros
Power EOL capability - orbit avg (W) Voltage Battery Solar Arrays Cells Size (m^2)	230 28 V unregulated 21 A-hr NiCd 4 deployable fixed & 1 body mounted GaAs 3.4	50 28 V unregulated 9 A-hr NiCd body mounted GaAs 5.6	100 28 V unregulated 9 A-hr NiCd 2 deployable fixed GaAs 1.7	210 28 V unregulated 9 A-hr NiCd 2 deployable fixed GaAs 2.5	230 28 V unregulated 9 A-hr NiCd 4 deployable fixed GaAs 2.5
Thermal	-15 to +50 C passive w/heaters	-15 to +50 C passive w/heaters	-10 to +50 C passive w/heaters	-20 to +50 C passive w/heaters	-20 to +50 C passive w/heaters
Mechanical/Structure	Aluminum	Aluminum	Aluminum	Aluminum/Comp.	Aluminum
Reaction Control Subsystem	N/A	N/A	N/A	N/A	N/A
Ground Station Quantity Location Contacts	1 WFF 2-3 ground contacts/day	varies WFF, DSN, Poker Flats varies	1 WFF two 10-minute ground contacts/day	2 WFF & Poker Flats 2 contacts/day	2 WFF & Poker Flats up to 6 ground contacts/day

3 With instrument provided star tracker
4 After ground processing
5 From instrument provided guide telescope
 Using telescope image motion compensation mechanism

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TABLE B-3 (CONT.) CHARACTERISTICS OF SMEX MISSIONS

Item	SWAS	FAST	SAMPEX	WIRE	TRACE
Mission Operations Center	Mission scheduling, health and safety, analysis, level 0 processing. Located at GSFC Shared Operations	Mission scheduling, health and safety, analysis, level 0 processing. Located at GSFC Shared Operations	Mission scheduling, health and safety, analysis. Located at GSFC Shared Operations	Mission scheduling, health and safety, analysis, level 0 processing. Located at GSFC Shared Operations	Mission scheduling, health and safety, analysis, level 0 processing. Located at GSFC Shared Operations
Science Activities					
Science Operations Center Location	SAO	UCB	U. of Md	CIT/IPAS	GSFC
Science Data Volume	120 Mbytes/day	varies	20 Mbytes/day	95 Mbytes/day	32[illegible] MBytes/day
Observation Strategies	Radiometer and acousto-optical spectrometer measurements of interstellar clouds. 3-5 targets per orbit	High time and spatial resolution plasma measurements at apogee	Particle detection	Accumulate 6 million seconds w/in 50° of North/South galactic poles and outside of ±20° of ecliptic	Accumulate nine 27-day periods of uninterrupted sun-viewing.

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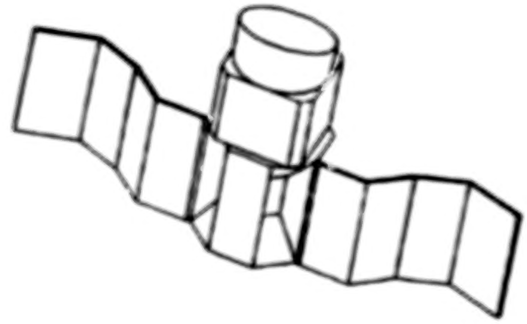

FIGURE B-2 THE SWAS MISSION.

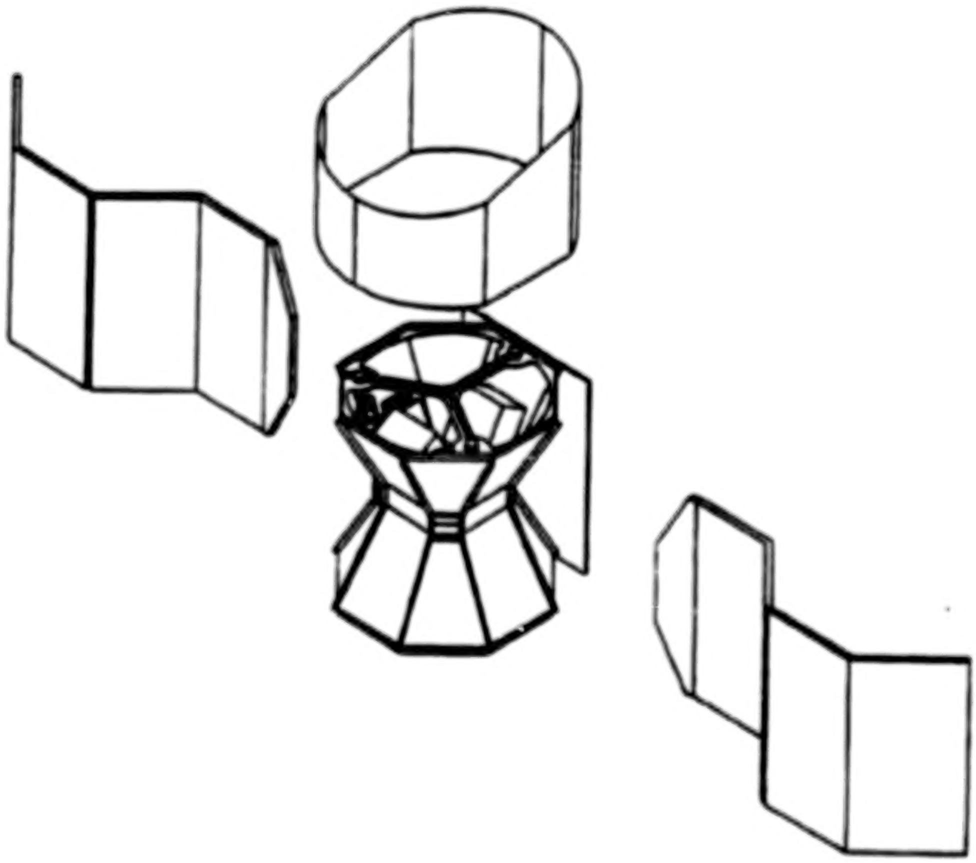

FIGURE B-3 AN EXPLODED VIEW OF THE SWAS INSTRUMENT AND SPACECRAFT.

Four deployable, nonarticulated solar panels and one body-mounted panel contain gallium arsenide solar cells totaling 3.4 square meters and provide 230 watts of orbital average power that is distributed to the spacecraft and instrument via an unregulated 28 volt bus. A 21 amp-hour nickel-cadmium battery is included in the spacecraft to provide power during eclipse and when load demands exceed the solar array power output. The orbital average power consumption of the spacecraft hardware is 133 watts. The instrument consumes 59 watts.

Temperatures of the spacecraft subsystems are maintained passively between -15 Celsius and +50 Celsius by using surface finishes, regulated conduction paths, blankets, and thermostatically controlled heaters.

The C&DH system for the SWAS mission includes dual 32-bit processors and 70 megabytes of bulk memory. All subsystems and the instrument interface to the C&DH via a MIL-STD 1553 data bus. Instrument data are collected at approximately 12 kbps average rate. A NASA standard S-band transponder and a five-element, micro-patch antenna completes the C&DH system. The stored data are transferred to the ground at 1.8 Mbps data rate. Commands are uplinked at 2 kbps transmission rate.

The instrument weighs 71 kg and attaches to the top of the spacecraft structure as a single module. The total observatory mass is 252 kg. The SWAS mission is to be operated in a 600 km circular orbit with a 65 degree inclination.

B. FAST Spacecraft Design

The FAST spacecraft is a 12 rpm, spin stabilized spacecraft with its spin axis oriented parallel to the orbit axis. The instrument electronics include a 32-bit data processing unit which performs the science data processing and recording in a one-gigabit, solid-state memory. The stored data are transferred to the ground at one of three selectable high data rates of 900 kbps, 1.5 Mbps, and, for certain ground stations, 2.25 Mbps. The instruments weigh 51 kg; the total observatory mass is 180 kg. The FAST mission requires 1 year of operation in a 350 X 4,200 km, 83 degree inclination orbit. Schematics of the FAST instrument and spacecraft payload, both assembled and as subsystems, are shown in Figures B-4 and B-5. A block diagram of the spacecraft architecture is shown below in Figure B-6.

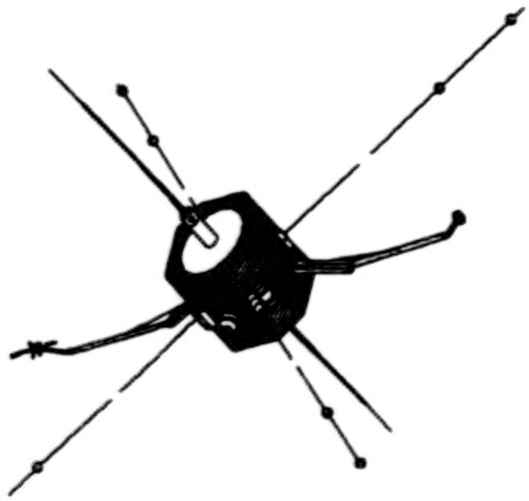

FIGURE B-4 THE FAST MISSION.

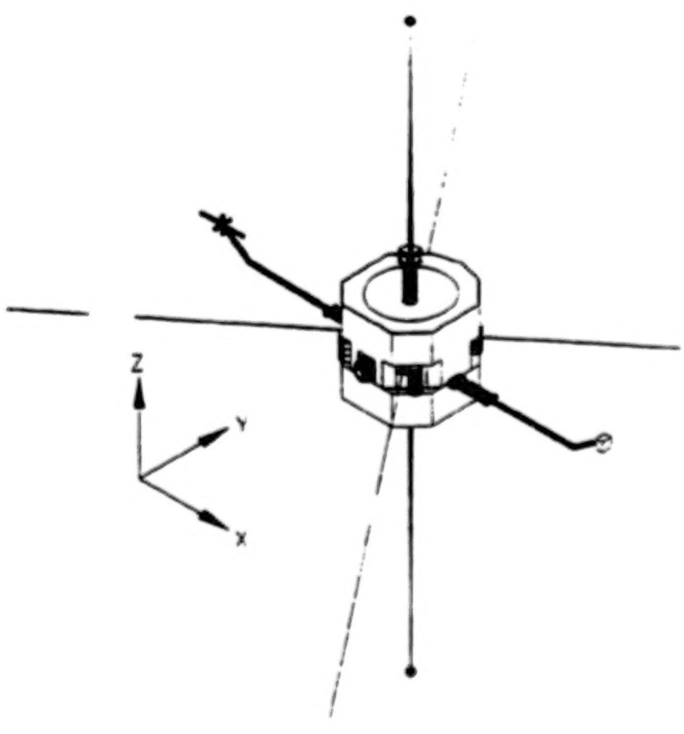

FIGURE B-5 AN EXPLODED VIEW OF THE FAST INSTRUMENT AND SPACECRAFT.

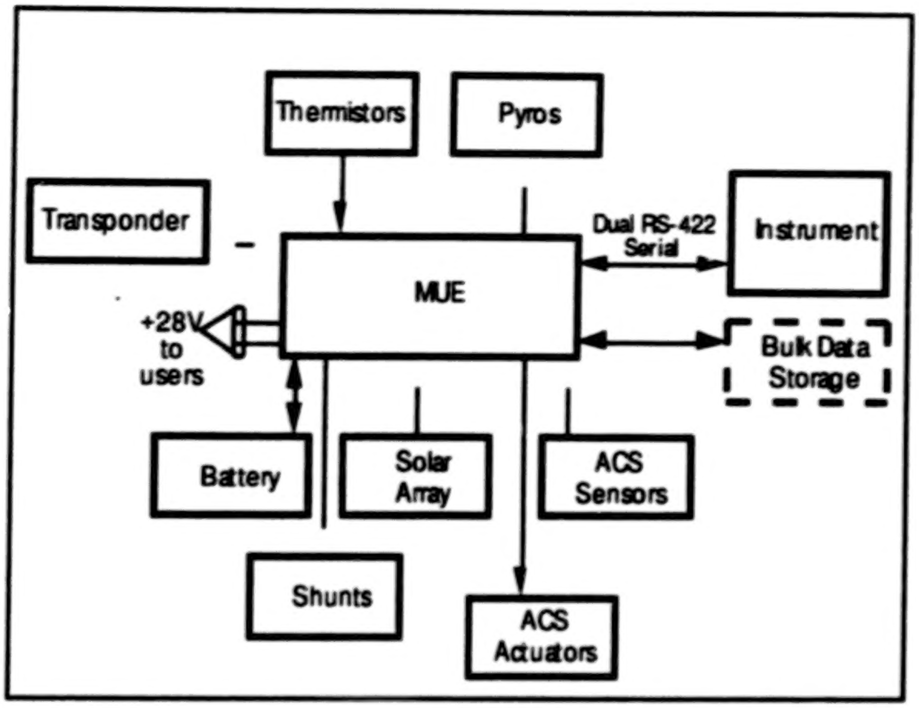

FIGURE B-6 BLOCK DIAGRAM OF THE FAST SPACECRAFT

The Mission Unique Electronics (MUE) perform all major spacecraft functions including command and data handling, attitude control, battery charge control, power distribution, firing pyrotechnic devices, spacecraft health and safety functions, and instrument and launch vehicle interfacing. The spacecraft computer performs power distribution, data encoding/decoding, and launch vehicle interface. Each functional capability has been minimized in order to conserve mass and power.

The MUE computer consists of dual, 8-bit, 80C85 microprocessors, a minimal analog ACS controller, and an analog battery charge controller. Ground commands are received at 2.0 kilobits per second. Health and safety telemetry is downlinked at 4.0 kilobits per second. The higher telemetry downlink rates (up to 2.25 Mbps for some stations) are driven by the instrument electronics. All telemetry is encoded to reduce errors. The dual 8-bit, 80C85 microprocessors, a NASA S-band transponder (same as the baseline architecture), and a four element high gain micropatch antenna comprise the command and data handling system for the FAST spacecraft. Spacecraft time is maintained to better than 3 seconds.

The MUE has no data storage capability except for a small housekeeping buffer. With some modifications the MUE can control a solid state bulk-data storage device (shown

in broken lines in Figure B-6, but not required for the FAST mission), although it can only accept instrument data into the solid state recorder at rates less than 4.0 kbps. A MUE-controlled solid state bulk-data storage device can only be dumped for downlink at 4.0 kbps. In the FAST mission the MUE allows the instrument to downlink its own stored data at the higher rates.

The FAST power system consists of body-mounted gallium arsenide solar cells totaling 5.6 square meters which typically generate 50 watts of orbit-average power. Power is distributed to the spacecraft and instruments via an unregulated 28-volt bus. A 9 amp-hour nickel cadmium battery is included in the spacecraft to provide power during eclipses and when load demands exceed the solar array power output. The orbit average power consumption of the spacecraft hardware is 33 watts. The instruments consume 15 watts orbit-average power, 31 watts when operating. Instruments are frequently powered off in order to maintain a positive energy balance. The power system electronics in the MUE is similar to the baseline power system, but with a cruder battery charging control allowed by the shorter (1 year) mission life requirement. The system capacity is approximately 100 watts, the power bus characteristics are identical to the baseline power system, and peak loads are limited to 1/2 of the selected battery rating (4.5 amp-hour).

The ACS capabilities of the FAST spacecraft are limited to simple designs that can be implemented with analog controllers, with limited support provided by the MUE microprocessor. The FAST mission ACS uses a 3-axis magnetometer, a spinning sun sensor, a horizon crossing indicator, and two air-coil magnetic torquers. Spin rate and spin-axis orientation are maintained by the magnetic torquer coils. The ACS provides closed-loop spin-rate control. Spin-axis precession is performed open loop and is closed via ground commands. After computation on the ground, attitude knowledge is accurate to within one degree. Definitive attitude and orbit determination must be done on the ground.

The FAST thermal system design follows the same philosophy as the baseline spacecraft architecture. Temperatures of the spacecraft subsystems are maintained passively between -15 Celsius and +50 Celsius by using surface finishes, limited conduction paths, blankets, and thermostatically controlled heaters.

C. SAMPEX, WIRE, and TRACE Spacecraft Designs

Schematics of the SAMPEX, WIRE, and TRACE instrument and spacecraft payloads, both assembled and as subsystems, are shown in Figures B-7 thru B-12.

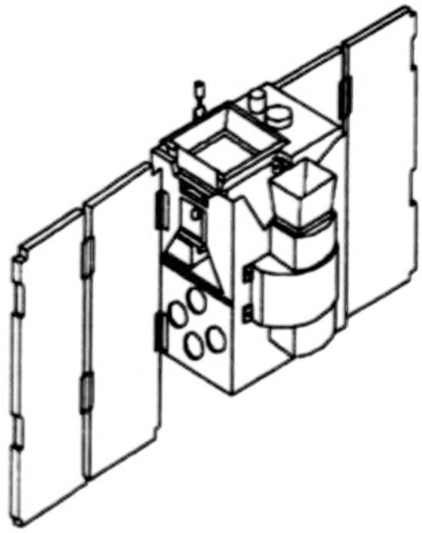

FIGURE B-7 THE SAMPEX MISSION.

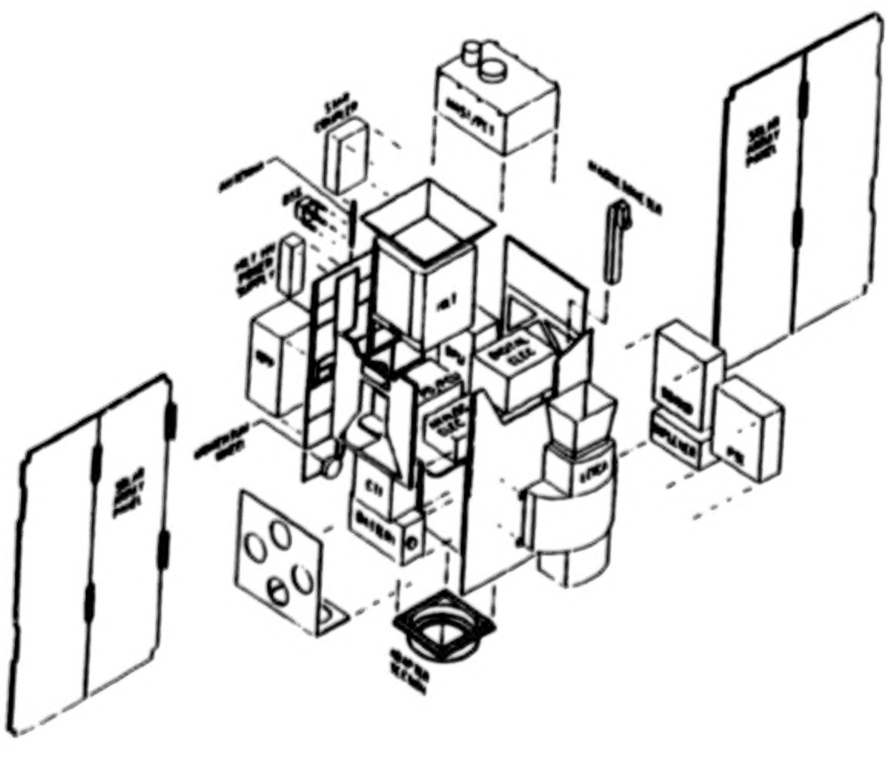

FIGURE B-8 AN EXPLODED VIEW OF THE SAMPEX INSTRUMENT AND SPACECRAFT

FIGURE B-9 THE WIRE MISSION

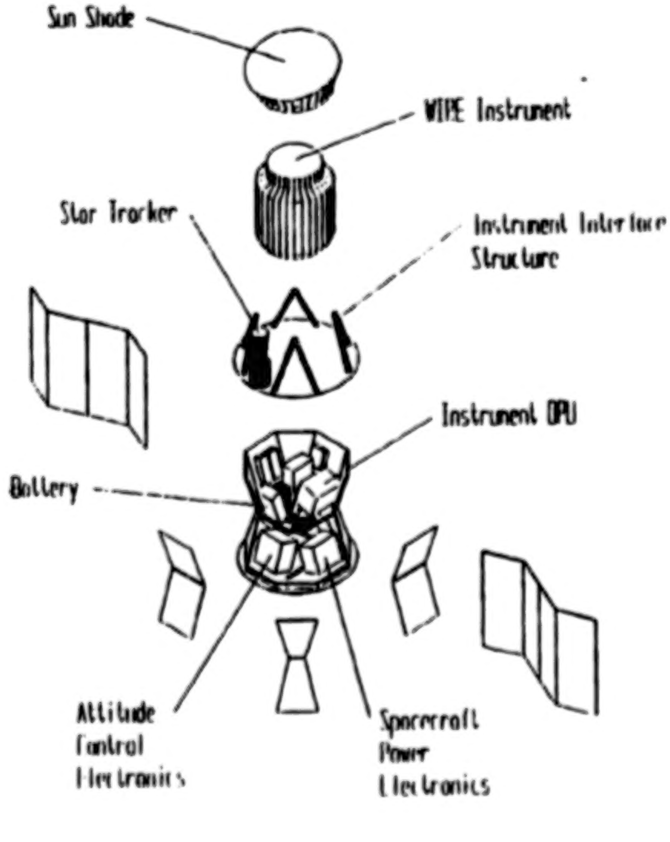

FIGURE B-10 AN EXPLODED VIEW OF THE WIRE INSTRUMENT AND SPACECRAFT

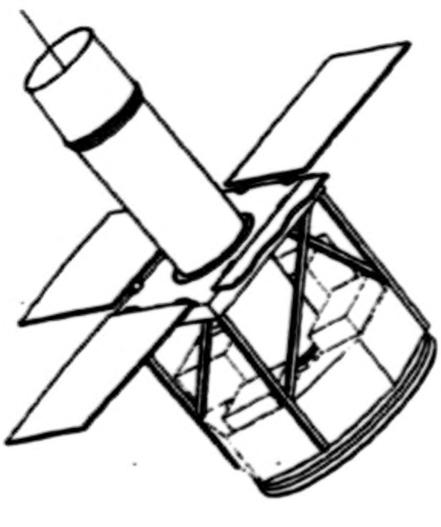

FIGURE B-11 THE TRACE MISSION

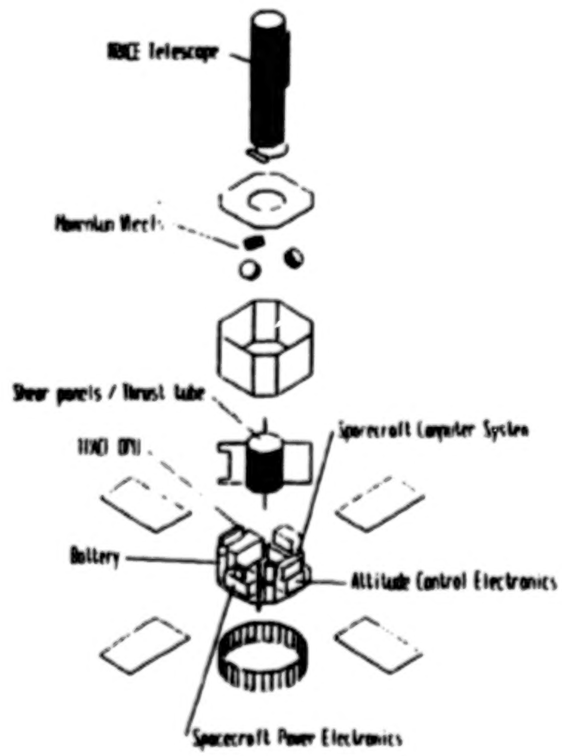

FIGURE B-12 AN EXPLODED VIEW OF THE TRACE INSTRUMENT AND SPACECRAFT

Request for general radiation information

Provide the following information to determine the radiation sensitivities of the mission orbit:

Apogee (km)	____________
Perigee (km)	____________
Inclination (deg)	____________
Argument of Perigee (deg)	____________
Lifetime	____________

Send the above information to the following:

Name: Mr. Ken LaBel
[illegible]

FAX: (301) 344-1719

E-Mail: Ken_LaBel@ccmail.gsfc.nasa.gov

FIGURE B-13 RADIATION QUESTIONNAIRE

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APPENDIX C

Medium Explorer Ground System and Operations

1. GENERAL

The standard ground system architecture and its functional capabilities as defined for the MIDEX program are described in this Appendix. The elements of this architecture are proven, and currently support a variety of NASA missions including the Small Explorer (SMEX) missions. By providing an architecture based on proven building blocks, maximum flexibility to adapt to specific mission needs is achieved while preserving the cost saving features of maintaining common elements from mission to mission. The fundamental capabilities of these elements are based upon the Consultative Committee on Space Data Systems (CCSDS) standards and can support a wide range of implementations. Investigators may propose an implementation independent of the functions or capabilities defined in this Appendix, although the associated costs must be identified and included in the proposed instrument cost. It is expected that the implementation details necessary to satisfy specific mission needs will evolve in conjunction with the spacecraft and instruments during the definition phase in order to ensure a cost effective approach.

To the greatest extent possible, MIDEX missions will be supported from a common Mission Operations Center (MOC). Taking a multimission approach to the MOC allows MIDEX to share pre- and postlaunch resources for integration and testing, nominal operations and anomaly resolution. The sharing of resources, as demonstrated by the SMEX program, can result in considerable savings to the missions. During the definition phase, a cost effective plan for utilization of MIDEX mission operations resources will be developed. The cost associated with the day to day operation of the MOC (i.e., starting 31 days after launch) by the Flight Operations Team will be included in the MO&DA costs.

In keeping with the philosophy of the program, MIDEX ground operations are structured to balance cost and science return. Proposed investigations should

assume that 90% of the science data will be delivered to the Science Operations function. This means that, although unlikely, the equivalent of up to 1 to 2 days of data may not be delivered in a given month. Such an accommodation allows for simpler, more autonomous implementations, with longer response times allowed for anomalies. Examples of anomalies are spacecraft safe hold and communication line outages.

Figure C-1 illustrates the MIDEX ground system functional architecture. The architecture has three parts: Networks, Mission Operations and Data Handling, and Science Operations. Within the bounds of the capabilities advertised in this Appendix, and allowing for some minor mission unique enhancements, the Network and Mission Operations and Data Handling functions will be configured by NASA at no cost to the proposer. The Science Operations function is expected to be provided and costed by the proposer. If a proposer seeks to use an implementation independent of, or with major deviations from, the functions or capabilities defined in this Appendix, the costs associated with such an implementation must be identified and included in the instrument cost. Examples of minor mission unique enhancements are customization of the

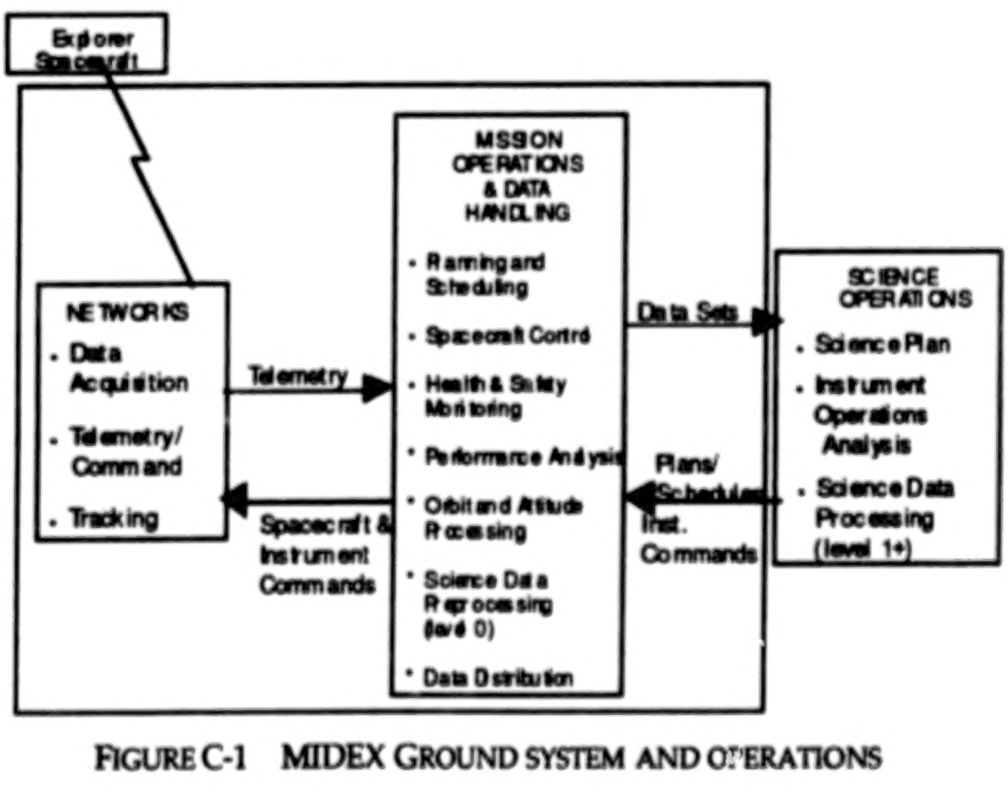

FIGURE C-1 MIDEX GROUND SYSTEM AND OPERATIONS

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planning and scheduling system for the mission unique resources, adaptation of attitude processing for the mission specific sensors, and definition of data set sizes. Examples of major deviations are the use of other than CCSDS standards for command or telemetry formats or orbit determination on the ground using other than standard tracking data.

2. NETWORKS

Networks are the interface between the spacecraft and the rest of the ground system. The networks acquire telemetry data from the spacecraft, send up-link commands, and track the spacecraft orbit if required. Telemetry and command transmission will use the international CCSDS Advanced Orbiting System (AOS) and Telecommand standards. Additional information can be obtained from the Explorers Project Library (see Section VIII.H in the body of this AO).

A standard set of launch and normal operations ground stations are available to a new mission. Potential sites include the Deep Space Network (DSN), the NASA Wallops Flight Facility (WFF), and high latitude ground stations such as the stations in McMurdo, Antarctica, and Fairbanks, Alaska. Optional implementations such as a Transportable Orbital Tracking Station (TOTS), a low cost ground station at the investigator's site or at another location connected to the investigator's site by communications links, or the Tracking and Data Relay Satellite System (TDRSS) may be made available, at no cost to the proposer, on a case by case basis. Since other developmental and/or operational costs may be incurred in the implementation of any of these options, requirements and capabilities trades during the definition phase will determine the most cost effective approach for the selected mission. Therefore, for proposal purposes only, the standard set of capabilities can be guaranteed at no cost to the investigator. Network support outside this envelope must be costed separately by the proposer. The MIDEX Program will act as the broker for the standard network commitments. The capabilities of the standard network elements are summarized in Table C-1. A lightweight TDRSS transponder/antenna will typically support about 2 Mbps of telemetry data and 2 kbps of command data.

TABLE C-1 STANDARD NETWORK ELEMENT CAPABILITIES

Networks	Contact Duration	Contact Frequency	Maximum Downlink Data Rate	Maximum Communi-cations Rate to U.S.	Maximum Uplink Rate	Comments
WFF	~10 minutes for LEO	One per day to one per orbit, depending on orbit	2.5 Mbps	~1.4 Mbps	2 kbps typical	
TOTS-"like"	~10 minutes for LEO	One per day to one per orbit, depending on orbit	2.5 Mbps	~1.4 Mbps (current capability)	2 kbps typical	High latitude site, local site
DSN	~10 minutes for LEO	One per day to one per orbit, depending on orbit	2.4 Mbps	~670 kbps	2 kbps typical	California, Australia, Spain

For low earth orbits; rates depend on spacecraft communications equipment

3. MISSION OPERATIONS AND DATA HANDLING

Mission Operations provides planning and scheduling of spacecraft operations, spacecraft control, orbit prediction, and spacecraft performance analysis. Spacecraft and network support schedules are integrated with science plans before integrated command loads are created for uplink to the spacecraft. Real-time control of the spacecraft and instruments, command verification, fault detection, and fault correction activities can be augmented with trend analyses in the event of an anomaly to assist in assessing the spacecraft and instrument health.

Normal operations facilities will be shared among missions at GSFC to lower mission operations costs. A basic Flight Operations Team is provided within the baseline ground system to provide basic planning and scheduling, real time health and safety operations around the clock, and, when needed, spacecraft analysis.

If required, orbit determination can be provided as part of the baseline ground system with accuracy dependent on frequency of contact, orbit profile, and drag (5 km accuracy is typical when there are 2 to 4 geometrically distributed daily contacts with the spacecraft). Prelaunch orbital analysis is performed as part of the

ground system baseline to address health and safety issues, such as network coverage, tracking requirements analysis, and prediction of spacecraft sun/shadow cycles. Orbit analysis for science drivers (e.g., unique launch window requirements, science viewing analysis, South Atlantic Anomaly studies) are not in the baseline and should be identified and costed in the proposal.

A launch and special operations area and support are available at GSFC for initial operations. This special operations area will also be available to spacecraft subsystem specialists to work mission anomalies during the mission life. Standard components, chosen to match the spacecraft interfaces, are used for the mission operations functions and are available to support the integration and test of both the spacecraft and instruments.

Data Handling includes science data preprocessing and data transport to the science center (if required). Data preprocessing (also called level 0 processing) consists of removing communication artifacts, sorting, ordering, and assembling the data into data sets. The following performance will be available as part of the ground system baseline (larger volumes of data can be handled at additional cost):

- Up to 500 Megabytes per day will be delivered within 24 hours of receipt of a day's sets of data.
- Up to 15% of the data can be delivered within 2 hours of receipt as a quicklook data service.
- Distribution of science data will be electronic, using TCP/IP (transmission control protocol/Internet protocol), unless it is cost effective to send physical media, such as optical disks.

For some spacecraft (for example, those with long contact times and a tight coupling between science and spacecraft operations), a stand-alone spacecraft operations facility combining both Mission Operations and Data Handling and Science Operations functions is appropriate. The software and hardware designs associated with standard system components can be provided to the investigator for performing many of the Mission Operations and Data Handling functions as an alternative to having the service performed by GSFC. The location of standard elements at a user facility will be provided if demonstrated to be cost effective during definition. Operations of these components will be included in the MO&DA cost.

Other options that are available include real time control of the instrument by the investigator when communications contacts exist and rapid replanning within

2 hours for targets of opportunity and contingencies. Possible implementation of these options will be determined on a case-by-case basis during definition.

4. SCIENCE OPERATIONS

Science Operations, which are normally done at the investigator's institution, are not provided as part of the standard ground system. This function includes science data processing, data archiving, payload scheduling, and instrument anomaly resolution. The Science Operations functions should be proposed as a stand-alone system separate from the Mission Operations and Data Handling functions. There may be cost or technical advantages to integrating these functions or providing common solutions with the Mission Operations and Data Handling functions. These potential savings will be explored during the definition phase.

5. EXAMPLE SMALL EXPLORER MISSION GROUND SYSTEM IMPLEMENTATION

The Medium Explorer spacecraft will be supported by a ground system whose heritage includes the SMEX Mission ground system. The following description is included for reference and is illustrated in Figure C-2. It reflects the common capabilities used to support the SMEX Spacecraft, although some of the functions have been moved and updated to reflect the evolving ground system architecture. Each specific SMEX spacecraft has unique functions and interfaces that are not shown in this example.

The SMEX spacecraft use a ground station at the Wallops Flight Facility as the primary space-to-ground link. A Transportable Orbital Tracking Station or the Deep Space Network are used as backup stations. The spacecraft has several contacts per day for tracking, telemetry, and command. The uplink rate is 2 kbps. The downlink rate is approximately 1.8 Mbps. CCSDS formats are used for commands and telemetry. The telemetry data is captured at the ground station and selected virtual channels, including the housekeeping data, are sent in real time to the MOC at GSFC. The rest of the data is buffered and sent after the contact at a rate lower than the real time rate.

NASCOM communications are used between the ground stations and the MOC.

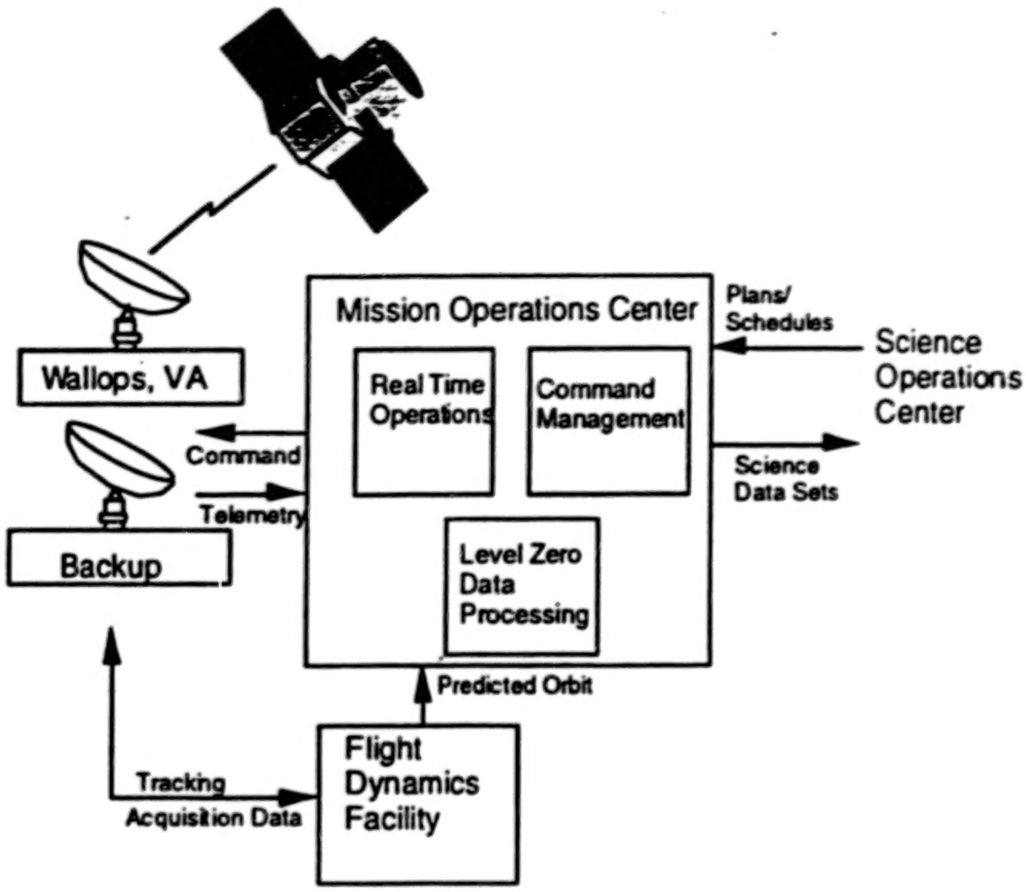

FIGURE C-2 SMALL EXPLORER GROUND SYSTEM EXAMPLE

The MOC is located at GSFC. It supports all of the SMEX spacecraft. There are sufficient equipment and personnel associated with the MOC to prevent this sharing from being a constraint on any particular spacecraft's operations. The MOC performs mission planning and scheduling, command load generation, housekeeping telemetry processing, commanding, attitude monitoring and calibration, spacecraft subsystem analysis, and level zero processing of the science data. The MOC is staffed around the clock.

The Mission Operations Center interfaces to a remote Science Operations Center (SOC). The MOC provides the SOC with planning information. The SOC provides the MOC with science schedules and command loads for the instruments. The MOC provides the SOC with science data. Science data can be provided as production data to the SOC within approximately 1 day. Production data is instrument data with the artifacts of the space to ground communications removed and quality and accounting information appended. Quick look data can

also be provided. Quick look data is available within a few hours but duplicate data is not removed and less quality and accounting information can be provided.

The institutional Flight Dynamics Facility at GSFC processes the tracking data from the ground station and generates acquisition data for the ground station and predicted orbit data and other planning aids for the MOC and SOC.

APPENDIX D

Performance Assurance Approach for MIDEX Missions

Reliability considerations for the MIDEX Program are bounded by programmatic demands for scientific excellence, low cost, and rapid development. As a result, systems are expected to be predominantly nonredundant or "single string." However, redundancy is encouraged where appropriate and where resources allow.

The performance assurance requirements for the MIDEX Program will be structured to accept the increased risk that is inherent in a predominately non-redundant system. Good quality parts and materials, a limited reliability and quality program, and significant reliance on the test program will be key factors in balancing reliability goals against program cost and complexity constraints.

The Principal Investigator has responsibility and control over development of the instrument(s) and, in the "PI-Mode," the spacecraft. Only limited support is planned by NASA, with emphasis on those activities that contribute most to product reliability and integrity. Deliverable documentation is reduced, provided the investigator maintains adequate internal records that demonstrate traceability when needed.

The performance assurance requirements for the MIDEX Program recognize a wide variation in complexity, size, and technology of proposed instruments and spacecraft; these all can affect program risk and costs. The requirements recognize that there are significant differences in the availability to investigators of facilities, skills, and supporting capabilities. The performance assurance program ensures that hardware and software are designed, manufactured, and tested to flight standards, and that drawing and specification requirements are met. Guidelines and requirements for conducting an appropriate performance assurance program are contained in the Medium Explorer Performance Assurance Requirements (PAR) document, available from the Explorers Project Library (see section VIII.H of

the body of this AO).

The proposer should refer to the PAR in developing his performance assurance approach and realistically addressing the costs associated with these tasks. During the definition phase of the mission the specific implementation details of the performance assurance program for the investigation will be negotiated. The quality program shall be modeled after ANSI/ASQC Q9001-1994, "Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing".

As part of the proposal submitted in response to this AO, a brief, 2-3 page description of the proposed approach to performance assurance is required. The performance assurance description should reflect the proposer's understanding of and approach to accomplishing the performance assurance requirements contained in the PAR. The description should also provide the basis for the performance assurance costs contained in the Proposal. The proposer is encouraged to make maximum use of existing practices and procedures in developing and implementing the performance assurance program. For requirements that are not fully applicable, because of a particular aspect of the instrument or mission, the proposer should provide appropriate rationale. The proposer may also offer an alternate method of meeting the intent of a requirement when such a method is better aligned with the manner in which the total work is to be accomplished. The proposer must describe the plans for maintaining adequate internal documentation for all performance assurance activities and for providing NASA with essential deliverable documentation.

APPENDIX E

General Instructions and Provisions

I. INSTRUMENTATION, SPACECRAFT, AND/OR GROUND EQUIPMENT

By submitting a proposal, the investigator and the proposing institutions agree that NASA has the option to accept all or part of the offeror's plan to provide the instrumentation, spacecraft, or ground support equipment required for the investigation, or NASA may furnish or obtain such instrumentation, spacecraft, or equipment from any other source as determined by the selecting official. In addition, NASA reserves the right to require use, by the selected investigator, of Government instrumentation or property that subsequently becomes available, with or without modification, that will meet the investigative objectives.

II. TENTATIVE SELECTIONS, PHASED DEVELOPMENT, PARTIAL SELECTIONS, AND PARTICIPATION WITH OTHERS

By submitting a proposal, the investigator and the organization agree that NASA has the option to make a tentative selection pending a successful feasibility or definition effort. NASA has the option to contract in phases for a proposed experiment, and to discontinue the investigative effort at the completion of any phase. The investigator should also understand that NASA may desire to select only a portion of the proposed investigation and/or that NASA may desire the individual's participation with other investigators in a joint investigation, in which case the investigator will be given the opportunity to accept or decline such partial acceptance or participation with other investigators prior to a NASA selection. Where participation with other investigators as a team is agreed to, one of the team members will normally be designated as its team leader or contact point.

III. SELECTION WITHOUT DISCUSSION

The Government reserves the right to reject any or all proposals received in response to this Announcement when such action shall be considered in the best interest of the Government. Notice is also given of the possibility that any selection may be made without discussion (other than discussions conducted for the purpose of minor clarification). It is, therefore, emphasized that all proposals should be submitted initially on the most favorable terms that the offerer can submit.

IV. NON-U.S. PROPOSALS

The following guidelines are established for non-U.S. responses to NASA's Announcement of Opportunity. Unless otherwise indicated in a specific announcement, these guidelines indicate the appropriate measures to be taken by non-U.S. proposers, prospective non-U.S. sponsoring agencies, and NASA leading to the selection of a proposal and execution of appropriate arrangements. They include the following:

a. Where a "Notice of Intent" to propose is requested, prospective non-U.S. proposers should write directly to the NASA official designated in the Announcement of Opportunity and send a copy of this letter to:

   Ms. Shiron Gaines
   Reference: AO-95-OSS-02
   Code IR
   National Aeronautics and Space Administration
   Washington, DC 20546
   U.S.A.

b. Unless otherwise indicated in the Announcement of Opportunity, proposals will be submitted in accordance with this Appendix except that a cost summary should be submitted in lieu of a detailed cost plan. Proposals should be typewritten in English, with all costs in U.S. dollars.

c. Persons planning to submit a proposal should arrange with an appropriate non-U.S. governmental agency for a review and endorsement of the proposed activity. Such endorsement by a non-U.S. organization indicates:

   1. The proposal merits careful consideration by NASA.
   2. If the proposal is selected, sufficient funds will be available to undertake the activity envisioned.

d. All letters of endorsement from the non-U.S. governmental agency along with one copy of the proposal must be forwarded to NASA in time to arrive before the deadline established for this Announcement of Opportunity. These documents should be sent to:

   Ms. Shiron Gaines
   Reference: AO-95-OSS-02
   Code IR
   National Aeronautics and Space Administration
   Washington, DC 20546
   U.S.A.

e. All proposals must be received before the established closing date; those received after the closing date will be treated in accordance with NASA's provisions for late proposals. Sponsoring non-U.S. government agencies may, in exceptional situations, forward a proposal directly to the above address if review and endorsement is not possible before the announced closing date. In such cases, NASA should be advised when a decision on endorsement can be expected.

f. Shortly after the deadline for this Announcement of Opportunity, NASA's International Relations Division will advise the appropriate sponsoring agency which proposals have been received and when the selection process should be completed. A copy of this acknowledgment will be provided to each proposer.

g. Successful and unsuccessful proposers will be contacted directly by the NASA Program Office coordinating the Announcement of Opportunity. Copies of these letters will be sent to the sponsoring government agency.

h. NASA's International Relations Division will then begin making the necessary arrangements to provide for the selectee's participation in the appropriate NASA program. Depending on the nature and extent of the proposed cooperation, these arrangements may entail:

   1. A letter of notification by NASA.
   2. An exchange of letters between NASA and the sponsoring non-U.S. governmental agency.
   3. An agreement or Memorandum of Understanding between NASA and the sponsoring non-U.S. governmental agency.

V. TREATMENT OF PROPOSAL DATA

It is NASA policy to use information contained in proposals and quotations for evaluation purposes only. While this policy does not require that the proposal or quotation bear a restrictive notice, offerors or quoters should, in order to maximize

protection of trade secrets or other information that is commercial or financial and confidential or privileged, place the following notice on the title page of the proposal or quotation and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals and quotations will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

RESTRICTION ON USE AND DISCLOSURE OF

PROPOSAL AND QUOTATION INFORMATION (DATA)

> The information (data) contained in (insert page numbers or other identification) of this proposal or quotation constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offerer, be used or disclosed for other than evaluation purposes; provided, however, that in the event a contract is awarded on the basis of this proposal or quotation the Government shall have the right to use and disclose this information (data) to the extent provided in the contract. This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

VI. STATUS OF COST PROPOSALS (U.S. PROPOSALS ONLY)

Submission of a Standard Form (SF) 1411, "Contract Pricing Proposal Cover Sheet" (included as Figures in Appendices F and H) for Phases I and II of the investigation (see Appendix G) is required as part of the Step Two cost proposal. The investigator's institution agrees that the cost proposal submitted in response to this Announcement is for proposal evaluation and selection purposes, and that, following selection and during negotiations leading to a definitive contract, the institution will be required to resubmit or execute all certifications and representations required by law and regulation.

VII. LATE PROPOSALS

The Government reserves the right to consider proposals or modifications thereof received after the date indicated for such purpose, should such action be in the interest of the Government.

VIII. SPACE TRANSPORTATION SYSTEM INVESTIGATIONS

(Not applicable to this Announcement.)

IX. DISCLOSURE OF PROPOSALS OUTSIDE GOVERNMENT

NASA may find it necessary to obtain proposal evaluation assistance outside the Government. Where NASA determines it is necessary to disclose a proposal outside the Government for evaluation purposes, arrangements will be made with the evaluator for appropriate handling of the proposal information. Therefore, by submitting a proposal the investigator and institution agree that NASA may have the proposal evaluated outside the Government. If the investigator or institution desire to preclude NASA from using an outside evaluation, the investigator or institution should so indicate on the cover. However, notice is given that if NASA is precluded from using outside evaluation, it may be unable to consider the proposal.

X. EQUAL OPPORTUNITY (U.S. PROPOSALS ONLY)

For any NASA contract resulting from this solicitation, the clause at FAR 52.222-26, "Equal Opportunity," shall apply.

XI. PATENT RIGHTS

1. For any NASA contract resulting from this solicitation awarded to other than a small business firm or nonprofit organization, the clause at NASA FAR Supplement (NFS) 18-52.227-70, "New Technology," shall apply. Such contractors may, in advance of contract, request waiver of rights as set forth in the provision at NFS 18-52.227-71, "Request for Waiver of Rights to Inventions".

2. For any NASA contract resulting from this solicitation awarded to a small business firm or nonprofit organization, the clause at FAR 52.227-11, "Patent Rights--Retention by the Contractor (Short Form)" (as modified by NFS 18-52.227-11), shall apply.

XII. DATA RIGHTS

For any NASA contract resulting from this solicitation, the clause at FAR 52.227-14, "Rights in Data - General" (as modified by NFS 18-52.227-14), shall apply.

XIII. SMALL AND SMALL DISADVANTAGED BUSINESS SUBCONTRACTING

1. For any NASA contract resulting from this solicitation, the clause at NFS 18-52.219-76, "NASA Small Disadvantaged Business Goal," shall apply.

2. For any NASA contract resulting from this solicitation which offers subcontracting possibilities, exceeds $500,000, and is with an organization other than a small business concern, the clause at FAR 52.219-9, "Small Business and Small Disadvantaged Business Subcontracting Plan," shall apply. The subcontracting plan should not be submitted with the proposal. However, offerors must submit subcontracting goals for both small and small disadvantaged business concerns in their proposals, and identify the work associated with each of the separate goals, as well as the contemplated subcontractors, if known. A comprehensive and compliant subcontracting plan shall be submitted immediately upon selection, and will be made part of the contract. Failure to submit and negotiate the subcontracting plan shall make the offerer ineligible for award of a contract.

3. In accordance with NASA Procurement Information Circular 92-7, "Achieving NASA's 8% Small Disadvantaged Business Goal," a <u>mandatory</u> small disadvantaged business goal equivalent to 8% of the <u>contract</u> value has been established for this procurement. In addition, a <u>mandatory</u> small business goal equivalent to 8% of the <u>contract</u> value has been established for this procurement. Offerors should make an independent assessment and are encouraged to propose higher goals. The subcontracting plan required by FAR 52.219-9 shall have small and small disadvantaged business goals that are equivalent to not less than the mandatory goals. Note that the mandatory goals are expressed as a percentage of the <u>contract</u> value, while the subcontracting plan requires them to be expressed as a percentage of <u>total planned subcontracting dollars.</u> For example, if the contract value is $1,000,000, and the mandatory small disadvantaged business goal is 8%, and the total value of planned

subcontracts is $400,000, then the subcontracting plan must contain a small disadvantaged business goal of at least 20% of the value of the planned subcontracts. The proposed approach to implementing these subcontracting goals is an evaluation criteria for Step-Two proposals as described in Section VII.C of this AO.

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APPENDIX F

Guidelines for Investigations Proposing a NASA-Provided Spacecraft

The following guidelines apply to the preparation of proposals by potential investigators selecting the NASA-provided spacecraft mode of implementation in response to this Announcement of Opportunity. The material presented is a guide for the prospective proposer and not intended to be all encompassing. The proposer should, however, provide information relative to those items applicable or as otherwise required by this AO.

The proposer should first submit a Step-One Proposal, as outlined below. Based on the evaluation of Step-One Proposals, NASA will select a number of investigations for furthe.. consideration. Each of these investigations will then submit a Step-Two Proposal, with evaluation leading to selection of two primary and two alternate missions, as described in Section I.B of the body of this AO.

The guidelines for the Cover Letter, Table of Contents, Identifying Information and Investigation Summary Form apply to both the Step-One and Step-Two Proposals. Guidelines specific to each proposal step follow.

Cover Letter

A letter or cover page should be forwarded with the proposal. It should be signed by the investigator and by an institutional official who is authorized to certify institutional support and sponsorship of the investigation and of the management of the proposal. It should also be signed by the authorizing official from each organization represented on the team who is authorized to commit that institution to the proposed investigation.

Table of Contents

The proposal should contain a table of contents.

Identifying Information

The proposal should contain a short descriptive title for the investigation, the names of all investigators, the names of all participating organizations or institutions and the full name, address, and telephone number of the Principal Investigator (PI).

Investigation Summary Form

The salient features of the proposed investigation should be summarized in an "Investigation Summary Form," which is provided as Figure F-7 at the back of this Appendix. A figure or drawing of the instrument and/or spacecraft may be included at the proposer's discretion.

STEP-ONE PROPOSAL

1. SCIENCE INVESTIGATION AND INVESTIGATION PLAN

This section should address the following:

a. Summary. A concise statement describing the investigation, its conduct, and the anticipated results.

b. Objective and Significant Aspects. A brief definition of the objectives, their value, and their relationships to past, current, and future effort. The history and basis for the proposal, including demonstration of the need for such an investigation. A statement of present development in the discipline field.

c. Investigation Approach

   1. Fully describe the concept of the investigation.
   2. Detail the method and procedures for carrying out the investigation.

The above information will constitute the Baseline Mission. This section must also identify a minimum acceptable data and scientific return for the mission (the Minimum Science Mission), below which the mission would not be worth pursuing. Options for descoping the mission from the Baseline Mission to the Minimum Science Mission, and their impact to the investigation, should be briefly discussed. Proposals should include only one Baseline Mission and one Minimum Science Mission. **NASA will not consider more than one Baseline Mission or Minimum Science Mission per proposal.**

2. TECHNICAL APPROACH

The Technical Approach should describe the method and procedures for investigation definition, design, development, manufacturing, integration and test, ground operations, and mission operations. This section should also describe the expected products and end items associated with each phase.

a. Mission Operations Concept and Requirements — This section should address the operational phase of the mission from launch to end of mission. The following elements should be addressed:

   1. Mission operations scenario
   2. Spacecraft pointing requirements
   3. Attitude determination
   4. Orbit determination
   5. Communications requirements
   6. Mission lifetime
   7. Launch and/or operational (data collection) window(s)
   8. Orbital requirements
   9. Use of NASA ground system and operations functions and capabilities defined in Appendix C

b. Instrumentation — This section should describe the instrumentation and the criteria used for its selection. A description of the instrument, including layout and block diagrams, should be provided. The state of maturity of the instrument, including breadboards, prototypes, existing instrumentation and heritage, should be described. Prior instrument investigation studies performed should be summarized. Instrument performance requirements should be related to the investigation goals and objectives for both the Baseline Mission and Minimum Science Mission as described in Section 1 above. A description of the technology/development risks and the plan to address them should be included. The following basic instrument information should be provided:

   1. size
   2. mass
   3. shape
   4. mechanical interface with the spacecraft
   5. field of view
   6. power consumption (nominal, peak, duty cycle, standby)
   7. basic functional description
   8. basic operational description

9. power interface

10. telemetry and command interface

c. Investigation requirements on the spacecraft — This section should discuss the instrument requirements on the spacecraft. Required spacecraft resources should be described and requests for capabilities beyond the baseline in Appendix B should be specifically identified. A description of the payload layout and configuration should be included. Key instrument features and sensitivities should be identified, including electrostatic discharge, magnetics, contamination, electromagnetic interference, etc.

d. Spacecraft -- This section should describe the spacecraft design concept based on the Medium Explorer Spacecraft defined in Appendix B or other spacecraft of known cost.

3. DATA REDUCTION AND ANALYSIS PLAN

This plan should detail the method and format of the data reduction and analysis effort. A plan and schedule for distribution of reduced data to Co-investigators should be included. The plan should also include a schedule for the submission of reduced data to the National Space Science Data Center (NSSDC), Greenbelt, MD. Justification must be provided for the need for, and duration of, any proprietary rights for the PI for any data obtained as part of the mission's scientific investigation.

4. MANAGEMENT PLAN

This section should summarize the investigator's proposed management approach. The management organization and decision-making process should be described, teaming arrangements should be discussed, and responsibilities of team members and institutional commitments should be detailed. Unique capabilities that each member organization brings to the team, as well as previous experience with similar systems and equipment, should be addressed.

A top-level schedule for the definition and development phases should be provided. Key interdependencies, critical paths, and long lead procurements should be identified.

5. COST PLAN (U.S. Investigations Only)

The cost plan should summarize the total mission cost by major categories of cost. Top level costs should be provided for the definition, development, and operations

phases. Proposers should refer to the Work Breakdown Structure (WBS) in Figure F-3 for cost elements to be considered in developing the top level costs.

The cost plan should include the following:

a. Breakdown of development and operations costs into the following broad categories (including budget reserve for each category):
    1. Instrument
    2. Spacecraft
    3. Mission systems integration and test
    4. Operations preparations
    5. MO&DA
b. Definition phase cost for the following cases:
    1. 10-month definition phase
    2. 22-month extended definition phase
c. Alternate investigation funding for 1 or 2 years
d. Rationale for cost and budget reserve

STEP-TWO PROPOSAL

VOLUME I

INVESTIGATION AND TECHNICAL PLAN

1. SCIENCE INVESTIGATION AND INVESTIGATION PLAN

This section should only address changes to the Science Investigation and Investigation Plan from the Step-One Proposal. Any descoping of the investigation from the Baseline Mission defined in Step-One should be identified.

2. TECHNICAL APPROACH

The Technical Approach should detail the method and procedures for investigation definition, design, development, integration, ground operations, and mission operations. This section should also detail the expected products and end items associated with each phase.

This section must be complete in itself without need to request additional data. Failure to furnish complete data may preclude evaluation of the proposal.

a. Mission Design — This section should fully describe the operational phase of the mission from launch to end of mission. The following mission elements should be addressed:

   1. Mission operations scenarios — preliminary mission timeline covering typical science operations scenarios indicating periods of acquisition, data downlink, etc.,

   2. Spacecraft pointing requirements:
      - where, when, which axis
      - accuracy
      - stability
      - special requests (maneuvers, Sun/Moon/Earth avoidance, etc.)

   3. Attitude determination
      - when
      - stability/accuracy

   4. Orbit determination — in-track, across-track, altitude, frequency

   5. Communications requirements — facilities, data rates, bit error rate, etc.

   6. Mission lifetime

   7. Launch and/or operational (data collection) window(s)
      - science related
      - other

   8. Orbital requirements:
      - required
      - desired
      - constraints (SAA avoidance, etc.)

b. Instrumentation — This section should fully describe the instrumentation and the criteria used for its selection. It should indicate items that are proposed to be developed, as well as any existing instrumentation or design heritage. Particular attention should be paid to describing any required technology development, the risks involved, and alternative approaches. Performance characteristics of the instrumentation should be related to the measurement and investigation objectives as stated in Section 1, for both the Baseline Mission and Minimum Science Mission. The following basic instrument information should be included:

1. size
2. mass
3. center of gravity
4. shape
5. mechanical interface with the spacecraft
6. thermal paths
7. field of view
8. power consumption (nominal, peak, duty cycle, standby)
9. basic functional description
10. basic operational description
11. power interface
12. telemetry and command interface

c. Spacecraft — This section should describe the spacecraft design concept and system architecture based on the Medium Explorer Spacecraft defined in Appendix B or other spacecraft of known cost. Required spacecraft resources should be described and requests for capabilities beyond the baseline in Appendix B should be specifically identified. Along with a description of the payload layout and configuration, this section should address accommodation of the instrumentation by the spacecraft as follows:

1. preferred launch orientation
2. instrument location constraints:
    - relative to other instruments
    - relative to spacecraft components
3. alignment to axis
4. baffling or other protection
5. thermal environment/temperature limits:
    - operational
    - survival
6. data processing (onboard and on the ground)
7. telemetry — type, quantity, sample rate, time tagging, format
8. commands — type, quantity, function, timing constraints, frequency
9. timing (clocks) — resolution, accuracy, transfer method
10. environmental sensitivities — electrical cleanliness, magnetic fields, contamination
11. data collection and storage — volume, frequency, speed/rate, bit error rate

12. required U.S. Government support — Government furnished equipment, services, facilities

d. Manufacturing, Integration, and Test — This section should describe the manufacturing strategy to produce and test the hardware/software necessary to accomplish the investigation. It should include a description of the main processes/procedures planned in the fabrication of flight hardware, software, transitioning from design to production, production personnel resources, incorporation of new technology/materials, and the preliminary test and verification program. A preliminary schedule for manufacturing, integration, and test activities should be included. A description of the planned end items, including engineering and qualification hardware, should be included. The use of any existing test facilities and processes should be described.

e. Mission Operations — This section should identify requirements for mission operations support including mission planning. Requirements should be referenced to the baseline functions and capabilities defined in Appendix C. Requests for enhancements beyond the baseline should be specifically identified. Special communications facilities that are needed must be described. Any special orbital requirements, such as time of month, time of day, phase of moon, and lighting conditions are to be given in detail. Describe real-time ground support requirements and indicate any special equipment or skills required of ground personnel.

f. Ground and Data Systems — This section should discuss the ground operations support required for the proposed investigation. Requirements should be referenced to the baseline functions and capabilities defined in Appendix C. Requests for enhancements beyond the baseline should be specifically identified. The approach to the development of the ground and data system (GDS), including the use, if any, of existing facilities should be described. Details of communications needs, tracking needs, and special techniques should be delineated. Describe the communications facilities that will be used, including any NASA facilities or special facilities. All usage of NASA communication facilities should be explicitly described. Any mission-unique facilities must be adequately described. Describe all communications, tracking, and ground support requirements. Describe the software development approach and its relationship to the spacecraft software development.

g. Performance Assurance — This section should contain the approach to performance assurance as described in Appendix D.

h. New Technology and Technology Transfer — This section should describe those technologies to be considered for potential application to the investigation and their rationale. The methods by which these new technologies will be assessed and their risks reduced, as well as the means to validate these technologies, should be described. The potential

for transfer of new technology from this mission to other applications in NASA, the Federal Government, and/or in the private sector should be described. Alternative approaches to the use of these new technologies should be identified.

3. DATA REDUCTION AND ANALYSIS PLAN

This section should only address changes to the Data Reduction and Analysis Plan from the Step-One Proposal.

VOLUME II

MANAGEMENT PLAN

The Management Plan should describe the management approach and the facilities and equipment required. This section sets forth the investigator's approach for managing the work, the recognition of essential management functions, and the overall integration of these functions. This section should specifically discuss the decision-making process to be used by the team, focusing particularly on the roles of the Principal Investigator and Project Manager in that process. The management plan gives insight into the organizations proposed for the work, including the internal operations and lines of authority with delegations, together with internal interfaces and relationships with NASA, major subcontractors, and associated investigators. It also identifies the institutional commitment of all team members, and the institutional roles and responsibilities. The use of innovative processes, techniques, and activities by mission teams in accomplishing their objectives is encouraged when cost, schedule, and technical improvements can be demonstrated.

a. Management Processes and Plans, Schedule, and Procurement Strategy — This section should describe the management processes and plans, schedules, and procurement strategy necessary for the logical and timely pursuit of the work, accompanied by a description of the work plan. This section should also describe the proposed methods of hardware and software acquisition. Specifically, it should include the following, as applicable:

1. Unique or proprietary capabilities that each member organization brings to the team, as well as previous experience with similar systems and equipment.

2. Management processes which the investigator team proposes to:
   a. develop and maintain the hardware and software requirements and specifications;
   b. manage and control development progress;
   c. manage and conduct technology development;
   d. manage and conduct design;
   e. manage, review, and control hardware/software, documentation, etc. changes;
   f. manage and conduct systems engineering and integration;
   g. manage and conduct procurement including make or buy decisions, subcontract management, etc.;
   h. manage and conduct the testing and verification programs, including final checkout and calibration;
   i. assure safety, reliability, and quality;
   j. manage and conduct mission operations;
   k. manage and conduct data reduction, analysis, and archiving;
   l. coordinate with team members and document agreements;
   m. manage and control finances within cost limitations; and
   n. report progress to NASA.
3. The specific decision-making process regarding all aspects of the investigation, including descoping, and the individual with ultimate decision-making authority in such cases.
4. Availability of proposed personnel on the team to successfully administer the investigation contract and technically monitor the implementation.

The schedule and work flow should be clearly laid out, and the method for internal review, control, and direction discussed, including whether or not a form of performance measurement system will be used.

b. Roles, Responsibilities, and Experience of Team Members — The roles, responsibilities, time commitment, and experience of all key personnel must be described in this section, with particular emphasis placed on the responsibilities assigned to the PI and the Project Manager. In addition, information should be provided which indicates what percentage of time will be devoted to the mission, the duration of service, and how changes in personnel will be accomplished.

1. Principal Investigator. The role(s), responsibilities, and time commitment of the Principal Investigator should be discussed here.
2. Project Manager. The role, responsibilities, time commitment, and experience of the Project Manager should be discussed in this section.

3. Other Key Personnel. The roles, responsibilities, time commitments, and experience of the Co-Investigators and other key personnel in the investigation should be described in this section.

The management structure of the investigation team must be described in the proposal. The proposal must identify the teaming approach to be used and describe the responsibilities of each team member and their contributions to the investigation.

Financial responsibilities of all team partners must be described. The mechanisms (contracts, subcontracts, cooperative agreements, memoranda of agreement, letters of endorsement, etc.) by which organizations commit to participate as partners on a proposing team must be clearly identified. Include a description of the fee strategy, where appropriate, and the rationale. The proposal signature page must include the signature of an official from each organization represented on the team or contributing to the investigation who is authorized to commit that organization to the proposed investigation. Failure to include any such authorization may be grounds for rejection of the proposal. Non-U.S. organizations participating as team partners must also meet this requirement.

Any experience (successes and failures) of team partners in meeting cost and schedule constraints in similar projects within the last ten years should be discussed.

c. Risk Management and Descope Options — This section should describe the approach to risk management to be taken by the team. Particular emphasis should be placed on describing how the various elements of risk will be managed to ensure successful accomplishment of the investigation within cost and schedule constraints. In the event risks cannot be managed successfully and mission objectives must be revised toward the Minimum Science Mission, then this section should briefly describe the descope options available, their phasing, and their effect on mission performance relative to the previously defined Minimum Science Mission. This section should identify the latest possible dates at which descope options may be implemented and the procedure by which they would be accomplished.

d. Facilities and Equipment — All major facilities, laboratory equipment, and ground-support equipment (GSE) (including those of the team's proposed contractors and those of NASA and other U.S. Government agencies) essential to the mission in terms of its system and subsystems are to be indicated, distinguishing, insofar as possible, between those already in existence and those that will be developed in order to execute the investigation. The outline of new facilities and equipment should also indicate the lead time involved and the planned schedule for construction, modification, and/or acquisition of the facilities.

e. Educational and Public Outreach — This section should discuss the degree to which this investigation will generate educational

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opportunities and contribute to the Nation's educational initiatives. The involvement of teachers and/or students in the investigation should be documented here, as should any educational activities to be implemented. Coordination and collaboration with educational institutions should be discussed. Activities to enhance the level of understanding and awareness of space science by the public should be described.

f. Small and Small Disadvantaged Businesses — This section should describe the opportunities offered by the investigation for small and small disadvantaged businesses. It should also describe the breadth of participation in the investigation by members of the industry, academic, not-for-profit, and Federal communities, as well as discussing the opportunities offered by the investigation for other members of these communities. This section should identify the percentage of work, expressed as percentage of total subcontract cost/price and total contract cost/price, to be performed by small businesses (SB's) and small disadvantaged businesses (SDB's). Goals for SB and SDB subcontracting are contained in Appendix E.

VOLUME III

COST PLAN (U.S. Investigations Only)

The cost plan should summarize the total investigation cost by major categories of cost as well as by function. The plan should address the definition, development, and operations phases.

1. The categories of cost should include the following:
   a. Direct Labor. List by labor category, with labor hours and rates for each. Provide actual salaries of all personnel and the percentage of time each individual will devote to the effort.
   b. Overhead. Include indirect cost, which because of its incurrence for common or joint objectives, is not readily subject to treatment as a direct cost. Usually this is in the form of a percentage of the direct labor costs.
   c. Materials. This should give the total cost of the bill of materials including estimated cost of each major item. Include lead time of critical items.
   d. Subcontracts. List those over $25,000, specify the vendor and the basis for estimated cost. Include any baseline or supporting studies.
   e. Other Costs. Costs not covered elsewhere.
   f. General and Administrative Expense. This includes the expenses of the institution's general and executive offices and other miscellaneous

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expenses related to the overall business.

g. Fee (if applicable).

2. Separate schedules summarizing cost by category and phase (in the format shown in Figures F-1 and F-2) should be provided for each functional element of the mission, as defined by the proposer's Work Breakdown Structure (WBS). A reference WBS for a NASA-provided spacecraft mission is included as Figure F-3. Costs should be presented at level 2 of the WBS (i.e., 1.0 Management; 2.0 Science Support; etc.) except where significant development work is included (e.g., 4.0 Instrument Systems). In these areas, costs should be allocated and presented to the subsystem level (e.g., 4.3 Instrument Data System), and a rationale for the estimate should be included. Costs should be presented in FY 1994 dollars. A NASA inflation index is included as Figure F-4. These rates will be used to convert FY 1994 dollars to bid rates unless the proposing organization has formally negotiated other rates. In that case, the negotiated rates should be provided in Figures F-1 and F-2. Guidelines for allocating costs between the instrument and the NASA-provided spacecraft are provided as Figure F-5.

3. Separate and complete cost plans are required for the case of a 10-month definition phase as well as a 22-month definition phase, as shown in Figures F-1 and F-2. Note that for the 22-month definition phase, funding for the first year is limited to $500,000. In addition, proposers shall complete a Standard Form (SF) 1411, included as Figure F-6, for Phases I and II (see Appendix G).

4. Proposers shall also separately propose costs necessary to cover 1 or 2 years of effort to maintain a nucleus of the investigation team, if selected as an alternate investigation.

SUMMARY OF ELEMENTS OF COST
(FY94 DOLLARS)

	PHASE I	PHASE II	PHASE III			TOTAL	PHASE IV MO&DA (BEGINS 31 DAYS AFTER LAUNCH)			
	10-MONTH DEFINITION	3-MONTH INITIAL DESIGN AND DEVELOPMENT	DESIGN, DEVELOPMENT & OPS (LAUNCH + 30 DAYS) YEAR 1*	YEAR 2	YEAR3	DEF., DESIGN & DEVEL.	YEAR 1	YEAR 2	YEAR3	TOTAL
DIRECT LABOR										
HOURS (BY LABOR CATEGORIES)										
COSTS (BY LABOR CATEGORIES)										
OVERHEAD ($/%)										
OTHER DIRECT COSTS										
SUBCONTRACTS**										
MATERIALS										
OTHER										
TOTAL ODC										
SUBTOTAL										
G&A ($/%)										
TOTAL COST										
FEE ($/%)										
TOTAL FY94$										
INFLATION FACTOR										

* COVERS A 9 MONTH PERIOD, I.E., PHASES II & III TOTAL 36 MONTHS

** FOR SUBCONTRACTS OVER $25,000, THE CONTRACTOR WILL PROVIDE THE SAME DETAILS AS IN THEIR OWN PROPOSAL.

FIGURE F-1 SUMMARY OF ELEMENTS OF COST

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SUMMARY OF ELEMENTS OF COST
(FY94 DOLLARS)

	PHASE I 22-MONTH DEFINITION YEAR1 YEAR2	PHASE II 3-MONTH INITIAL DESIGN AND DEVELOPMENT	PHASE III DESIGN, DEVELOPMENT & OPS (LAUNCH + 30 DAYS) YEAR 1* YEAR 2 YEAR3	TOTAL DEF., DESIGN & DEVEL.	PHASE IV MO&DA (BEGINS 31 DAYS AFTER LAUNCH) YEAR 1 YEAR 2 YEAR3 TOTAL
DIRECT LABOR					
HOURS (BY LABOR CATEGORIES)					
COSTS (BY LABOR CATEGORIES)					
OVERHEAD ($/%)					
OTHER DIRECT COSTS					
SUBCONTRACTS**					
MATERIALS					
OTHER					
TOTAL ODC					
SUBTOTAL					
G&A ($/%)					
TOTAL COST					
FEE ($/%)					
TOTAL FY94$					
INFLATION FACTOR					

* COVERS A 9 MONTH PERIOD, I.E., PHASES II & III TOTAL 36 MONTHS

** FOR SUBCONTRACTS OVER $25,000, THE CONTRACTOR WILL PROVIDE THE SAME DETAILS AS IN THEIR OWN PROPOSAL.

FIGURE F-2 SUMMARY OF ELEMENTS OF COST (EXTENDED DEF.)

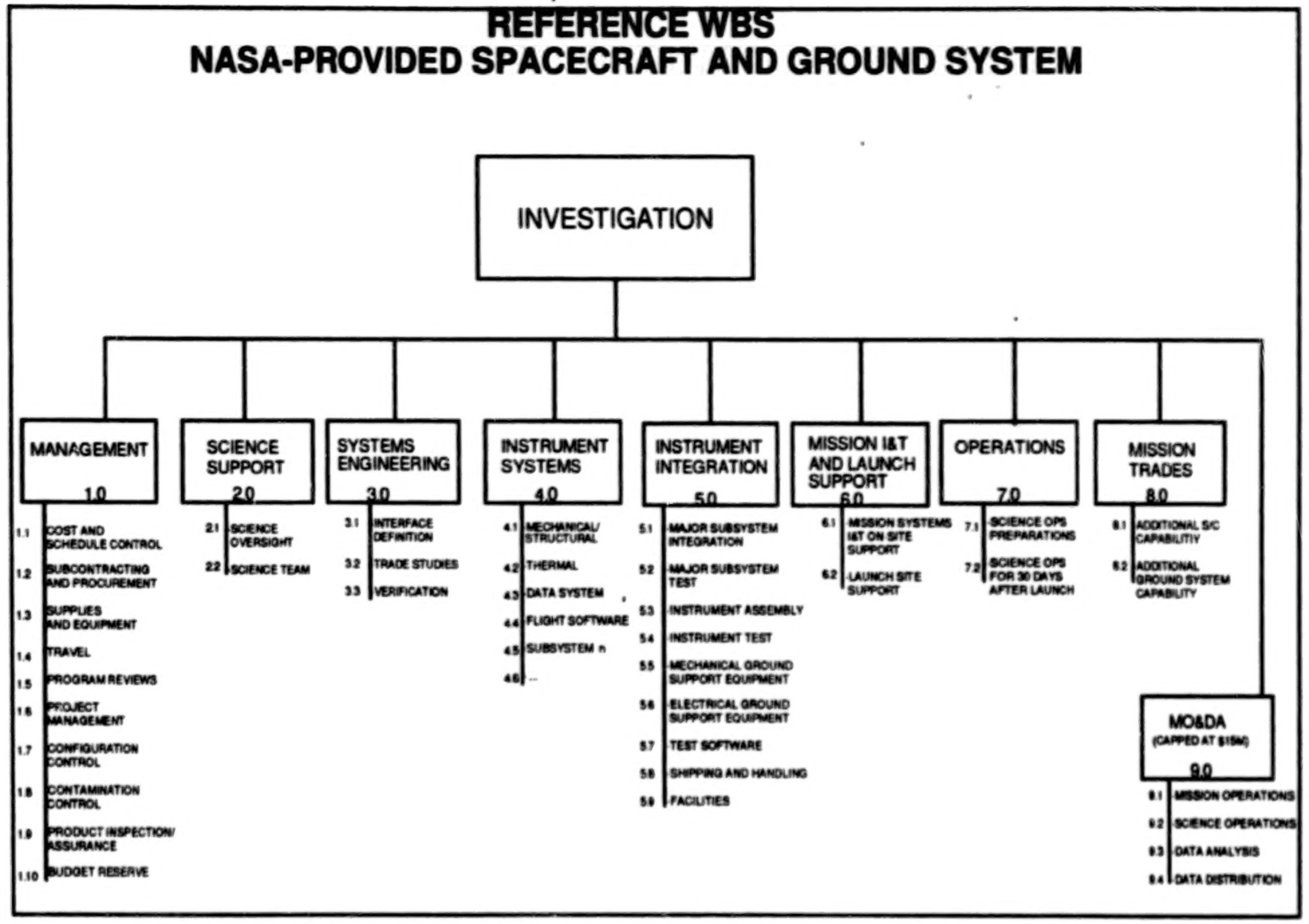

FIGURE F-3 REFERENCE WBS

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Fiscal Year	Inflation Rate
FY 1995	4.7%
FY 1996	4.8%
FY 1997	5.1%
FY 1998	5.1%
FY 1999	4.7%
FY 2000	4.4%
FY 2001	4.4%
FY 2002	4.4%
FY 2003 and Outyears	4.6%

FIGURE F-4 NASA INFLATION INDEX

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For investigations proposing to use a spacecraft provided by GSFC, costs for the definition and development of the instrument and science mission operations preparations should not exceed $40M in FY 1994 dollars, including a realistic budget reserve. The following costs must be accounted for within that cap:

- Science Support
- Science Payload Management
- Science Payload Systems Engineering
- Science Payload and Science Operations Preps Resource Management (Scheduling, Financial, etc.)
- Science Payload Definition
- Science Payload Development
    - Design
    - Fabrication/Procurement
    - Assembly/Integration
    - Qualification/Acceptance Testing
- Delivery and Checkout of Science Payload at GSFC or Spacecraft Contractor Facility
- Science Payload Support During Observatory I&T
- Science Payload Support at the Launch Site
- Science Payload Performance Assurance
- Science Payload Support to Mission Safety Program
- Science Operations Preparations, including Science Operations Center development
- Science Operations for 30 Days after Launch
- Spacecraft Optional Capability Above Baseline Defined in Appendix B
- Ground System and Operations Capability Above Baseline Defined in Appendix C
- Contamination Control Above "Visibly Clean" (Including Cost of Clean Rooms and Any Required Special Handling of the Spacecraft at GSFC, the Spacecraft Contractor's Facility or the Launch Site)
- GSFC Contractor Support Requested by PI
- Cost of Civil Servant and Contractor Support Requested by PI
- Cost of GSFC or Spacecraft Contractor Facilities Requested by PI
- Budget Reserve on All Above Costs

FIGURE F-5 ALLOCATION OF COSTS WITHIN $70M COST CAP

The following costs are allocated to the remaining $30M under the cost cap:

- Mission Management
- Project Scientist Support
- Mission Systems Engineering
- Mission Resource Management (Scheduling, Financial, etc.)
- Spacecraft Definition
- Development of Spacecraft with Capability Not to Exceed that Defined in Appendix B
  - Design
  - Fabrication/Procurement
  - Assembly/Integration
  - Qualification/Acceptance Testing
- Observatory Integration and Test
- Spacecraft Performance Assurance
- Observatory Performance Assurance
- Mission Safety Program
- Launch Vehicle Interface Support
- Transportation to Launch Site
- Launch Site Operations
- Mission Operations Preparations with Capability not to Exceed that Defined in Appendix C
- Mission Operations for 30 Days after Launch
- Non-Science Payload Contractor Support
- Cost of Non-Science Payload Civil Servants and Contractors
- Cost of Non-Science Payload Facilities Usage
- Budget Reserve on All Above Costs

FIGURE F-5 (CONT.) ALLOCATION OF COSTS WITHIN $70M COST CAP

CONTRACT PRICING PROPOSAL COVER SHEET

1. SOLICITATION/CONTRACT/MODIFICATION NO.

FORM APPROVED OMB NO. 9000-0013

Public reporting burden for this collection of information is estimated to average 4 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the FAR Secretariat (VRS), Office of Federal Acquisition Policy, GSA, Washington, D.C. 20405; and to the Office of Management and Budget, Paperwork Reduction Project (9000-0013), Washington, D.C. 20503.

NOTE: This form is used in contract actions if submission of cost or pricing data is required. (See FAR 15.804-6(b))

2. NAME AND ADDRESS OF OFFEROR (Include ZIP Code)

3A. NAME AND TITLE OF OFFEROR'S POINT OF CONTACT

3B. TELEPHONE NO.

4. TYPE OF CONTRACT ACTION (Check)

☐	A. NEW CONTRACT	☐	D. LETTER CONTRACT
☐	B. CHANGE ORDER	☐	E. UNPRICED ORDER
☐	C. PRICE REVISION/ REDETERMINATION	☐	F. OTHER (Specify)

5. TYPE OF CONTRACT (Check)

☐ FFP ☐ CPFF ☐ CPIF ☐ CPAF
☐ FPI ☐ OTHER (Specify)

6. PROPOSED COST (A+B=C)

A. COST	B. PROFIT/FEE	C. TOTAL
$	$	$

7. PLACE(S) AND PERIOD(S) OF PERFORMANCE

8. List and reference the identification, quantity and total price proposed for each contract line item. A line item cost breakdown supporting this recap is required unless otherwise specified by the Contracting Officer. (Continue on reverse, and then on plain paper, if necessary. Use same headings.)

A. LINE ITEM NO.	B. IDENTIFICATION	C. QUANTITY	D. TOTAL PRICE	E. REF.

9. PROVIDE NAME, ADDRESS, AND TELEPHONE NUMBER FOR THE FOLLOWING (If available)

A. CONTRACT ADMINISTRATION OFFICE

B. AUDIT OFFICE

10. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS WORK? (If "Yes," identify)

☐ YES ☐ NO

11A. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT? (If "Yes," complete Item 11B)

☐ YES ☐ NO

11B. TYPE OF FINANCING (✓ one)

☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS
☐ GUARANTEED LOANS

12. HAVE YOU BEEN AWARDED ANY CONTRACTS OR SUBCONTRACTS FOR THE SAME OR SIMILAR ITEMS WITHIN THE PAST 3 YEARS? (If "Yes," identify item(s), customer(s) and contract number(s))

☐ YES ☐ NO

13. IS THIS PROPOSAL CONSISTENT WITH YOUR ESTABLISHED ESTIMATING AND ACCOUNTING PRACTICES AND PROCEDURES AND FAR PART 31, COST PRINCIPLES? (If "No," explain)

☐ YES ☐ NO

14. COST ACCOUNTING STANDARDS BOARD (CASB) DATA (Public Law 91-379 as amended and FAR PART 30)

A. WILL THIS CONTRACT ACTION BE SUBJECT TO CASB REGULATIONS? (If "No," explain in proposal)

☐ YES ☐ NO

B. HAVE YOU SUBMITTED A CASB DISCLOSURE STATEMENT (CASB DS-1 or 2)? (If "Yes," specify in proposal the office to which submitted and if determined to be adequate)

☐ YES ☐ NO

C. HAVE YOU BEEN NOTIFIED THAT YOU ARE OR MAY BE IN NON-COMPLIANCE WITH YOUR DISCLOSURE STATEMENT OR COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)

☐ YES ☐ NO

D. IS ANY ASPECT OF THIS PROPOSAL INCONSISTENT WITH YOUR DISCLOSED PRACTICES OR APPLICABLE COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)

☐ YES ☐ NO

This proposal is submitted in response to the RFP, contract, modification, etc. in Item 1 and reflects our best estimates and/or actual costs as of this date and conforms with the instructions in FAR 15.804-6(b) (2), Table 15-2. By submitting this proposal, the offeror, if selected for negotiation, grants the contracting officer or an authorized representative the right to examine, at any time before award, those books, records, documents and other types of factual information, regardless of form or whether such supporting information is specifically referenced or included in the proposal as the basis for pricing, that will permit an adequate evaluation of the proposed price.

15. NAME AND TITLE (Type)

16. NAME OF FIRM

17. SIGNATURE

18. DATE OF SUBMISSION

NSN 7540-01-142-9845
7/87 edition is usable.

EXPIRATION DATE 7-31-93

1411-103

STANDARD FORM 1411 (REV. 2-91)
Prescribed by GSA - FAR (48 CFR) 53.215-2(a)

* U.S. Government Printing Office: 1993 - 342-049/80057

FIGURE F-6 SF 1411 (CONTRACT PRICING PROPOSAL COVER SHEET)

PROPOSAL #
NASA USE ONLY

Medium - Class Explorer (MIDEX)
Investigation Summary Form

PRINCIPAL INVESTIGATOR			
INSTITUTION			
DEPARTMENT			
ADDRESS / STREET			
CITY / TOWN	STATE	ZIP / POSTAL CODE	COUNTRY
TELEPHONE	FAX	E-MAIL ADDRESS	

INVESTIGATION TITLE
INVESTIGATION ABSTRACT (LIMIT 150 WORDS)

DISCIPLINE AREA (CHECK AS APPLY)

[ ] SPACE PHYSICS
- [ ] IONOSPHERIC
- [ ] MESOSPHERIC
- [ ] THERMOSPHERIC
- [ ] COSMIC
- [ ] MAGNETOSPHERIC
- [ ] HELIOSPHERIC
- [ ] SOLAR

[ ] ASTROPHYSICS
- [ ] RADIO
- [ ] INFRARED
- [ ] SUBMILLIMETER
- [ ] OPTICAL
- [ ] ULTRAVIOLET
- [ ] X-RAY
- [ ] GAMMA-RAY
- [ ] GRAVITY

SPACECRAFT MODE (CHECK ONE)
- [ ] NASA-PROVIDED
- [ ] PI-MODE

TOTAL BUDGET AMOUNT (EXCLUDING MO&DA)	TOTAL MO & DA BUDGET
$ ____________________	$ ______________

FIGURE F-7 INVESTIGATION SUMMARY FORM

PROPOSAL #
NASA USE ONLY

PRINCIPAL INVESTIGATOR
INVESTIGATION TITLE

LIST OF CO-INVESTIGATORS

NAME	INSTITUTION

INSTITUTIONAL ENDORSEMENT

INSTITUTION NAME	
NAME AND TITLE OF AUTHORIZING OFFICIAL	
SIGNATURE	DATE

FIGURE F-7 (CONT.) INVESTIGATION SUMMARY FORM

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APPENDIX G

Additional Information and Requirements

1. CONTRACT SUMMARY

When proposed investigations are selected for primary* definition studies, cost-reimbursable contracts will be implemented covering four phases. The basic contract will be for Phase I, which will cover either the 10-month or 22-month definition activity. Phase II will be a priced option and will provide a bridge from the end of the definition phase until Phases III and IV of the contract are negotiated. Phase II will cover a 3-month period of initial design and development of the investigation for flight. Phase III will cover the rest of the design, development, and mission operations effort through 30 days after launch. Phase IV will cover mission operations beginning 31 days after launch, data analysis, and the transition of data to public archives. Phases III and IV will be added to the contract during Phase II. If a proposed investigation is selected as an alternate*, a contract will be awarded for minimal effort to conduct preparatory definition studies and to maintain a nucleus of the investigation team.

2. DEFINITION STUDY (Basic, Phase I)

The following tasks should be accomplished during the definition study:

- Refine the science requirements and the mission requirements.
- Develop the system concept and the operating plan.
- Develop instrument support requirements and interface agreements between the instrument and the spacecraft.
- Identify high risk items and potential alternatives.
- Develop a plan for prioritized descoping of mission capability from the Baseline Mission to the Minimum Science Mission in the event of cost or schedule growth.

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* See Section I.B of this AO regarding primary and alternate investigations

- Assist the Project in developing the mission implementation plan.
- Prepare the Instrument Development Plan (Mission Development Plan for PI-Mode) for design, development, launch, mission operations, and data analysis.
- Develop the instrument (mission for PI-Mode) performance assurance program.
- Demonstrate technology and build breadboards as required.
- Develop a plan for education and public outreach.

In the case of the NASA-provided spacecraft, the GSFC Explorers Project will examine the performance of the spacecraft, launch vehicle, and communications networks needed to achieve the science requirements. The Project will assist the Principal Investigator in developing and analyzing the concept for the mission, including the configuration of the instrument and spacecraft subsystems, and the interface agreements among the major components. In the PI-Mode, the Principal Investigator will perform these tasks.

The schedule of planned activities and deliverables through the nominal 10-month definition phase is listed below. For the nominal 22-month definition phase, this schedule represents the final 10 months. Contract award is expected within one month after the mission is selected.

Activity	Time (months)
Contract award (Authorization to Proceed)	0
Definition of Level 1 requirements	1
Mission definition and requirements review	3
Preliminary development plan update due	4
Systems concepts and operating plan review	7
Final development plan due	8
Revised Phase III and IV proposal due	8
Preliminary Design Review/Non-Advocate Review	9
Confirmation Review	9
Confirmation of mission	9
Interface control document	9
Definition phase final report	10

Any modifications to the proposed work for Phases III and IV that come up during definition will be incorporated in a revised proposal that will include up-to-date pricing information and be submitted 8 months after contract award. In the same time frame, the investigation team will present definition study results to a NASA Headquarters review team. This team will examine the scientific and technical merit and relevance, technical feasibility and maturity, cost, management and other factors, and investigation team performance during definition. The review team will make a recommendation on the mission to the Associate Administrator for Space Science who will decide if it will be confirmed for development. Missions not confirmed for development will conclude their contracts with a final report due 10 months after contract award.

3. MISSION DEVELOPMENT (Phases II and III) and MO&DA (Phase IV)

For missions which are confirmed, the priced option will be exercised to implement Phase II by increasing the funding limit and initiating design and development. This modification is expected to be in place before the end of the 10-month basic period and permit a seamless transition from definition to development. A final report on the defined mission is also required for confirmed missions.

Audits of the up-to-date pricing information will also be initiated at confirmation. NASA expects that the 4 months of post-confirmation activity covered under Phases I and II will be sufficient to modify the contract to add Phases III and IV.

4. CONTRACT TERMS AND CONDITIONS

In order to expedite contract award after selection, the GSFC Explorers Project Library contains a sample contract schedule reflecting the basic contract terms and conditions for any cost-reimbursement Phase B instrument definition contract resulting from this AO. A cost-reimbursement instrument Phase C/D contract schedule is also available for review in the Library. Proposers should consider this

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information when preparing their proposals. No specific response is required unless exceptions are taken.

For those proposers proposing in the "PI-Mode," the Library contains sample contract schedules for cost-reimbursement Phase B and Phase C/D mission contracts. Also included is a firm-fixed price (FFP) spacecraft contract schedule to be considered when FFP subcontracting is appropriate. Proposers are encouraged to consider this information when preparing their proposals.

APPENDIX H

Guidelines for Investigations Proposing the PI-Mode

1. OVERVIEW

The following guidelines apply to the preparation of proposals by potential investigators selecting the PI-Mode of implementation in response to this Announcement of Opportunity. The material presented is merely a guide for the prospective proposer and not intended to be all encompassing. The proposer should, however, provide information relative to those items applicable or as otherwise required by this Announcement of Opportunity.

MIDEX PI-Mode teams may be led by Principal Investigators (PI's) at all categories of U.S. and non-U.S. organizations, including educational institutions, industry, nonprofit institutions, NASA Centers, and other Government agencies. Except as noted below, the NASA Goddard Space Flight Center (GSFC) will oversee selected PI-Mode investigations.

The PI-Mode should be implemented via teaming arrangements (consortia) among industry, university, and Government partners which optimize the talents of each of the organizations. The consortia may include members from one or more of the following: industry, a Federally Funded Research and Development Center (FFRDC), universities, and/or a Governmental organization, such as a NASA Center. Teams are encouraged to utilize industry participation to the fullest extent reasonable. NASA field centers, including the Jet Propulsion Laboratory, are welcome as mission team members. When a NASA field center participates as a member of a mission team, it should do so because it brings unique skills, facilities, and/or capabilities to the team. Teams will be led by the PI who will have the responsibility and accountability to accomplish the selected missions within the cost and schedule constraints of the program. Each PI-Mode investigation must have an experienced Project Manager (PM) who will oversee the technical and programmatic implementation of the mission. The role and experience of the PM must be adequate to insure that the technical needs of the investigation will be met. Investigator teams will be allowed to

use their own processes, procedures, and methods to the fullest extent practical, but are encouraged to develop and implement new ways of doing business when cost, schedule, and technical improvements can be achieved. NASA oversight and reporting requirements will be limited to that which is essential to enable mission success and agreed upon science return in compliance with committed cost, schedule, performance, reliability, and safety requirements.

PI-Mode mission proposals must include all technical aspects of the investigation from Definition (Phase B) through delivery of the data and its analysis (Phase E). NASA Handbook (NHB) 7120.5 ("Management of Major System Programs and Projects") delineates activities, milestones, and products typically associated with each of these phases and should be used as a reference in defining a team's mission approach.

The management approach taken by the PI can vary, as best suits the mission design, skills/expertise of the team members, and resources. For example, the PI can choose to delegate project management responsibility to a given individual within his/her team, including an industry participant. This person would assume responsibility for the technical implementation of the mission, including acquisition of the science data. In this arrangement, the PI's main responsibility remains the scientific integrity of the mission, with ultimate accountability to NASA for mission success. Another arrangement may have the PI team with a NASA Center, which would serve as the project management organization. An experienced project manager would be designated by the Center, with PI concurrence, and he/she would be responsible for the successful implementation of the overall mission, including the acquisition of science data. Again, the PI would retain responsibility for the scientific integrity of the mission. A third option would have the PI retain both project scientist and project management responsibilities. He/she would, therefore, be responsible for all aspects of the mission, both technical and scientific.

Industrial or FFRDC partners can be responsible for the entire design, development, integration and test of the spacecraft, or for the provision of required subsystems or instruments. Arrangements with these organizations will require signed agreements from each party identifying personnel and resources to be committed to the project.

NASA Centers may play different roles in the program, also. The Center may be a full team member, providing a wide range of contract administration, project management and mission development services, or the NASA Center may provide

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limited services, such as mission operations support, that can be arranged for by the PI or Project Manager. In either case, a signed agreement must be reached with that Center's management, committing people, facilities, or other resources to the project.

Different mission organizational arrangements will require different management and procurement approaches, contract administration, and oversight arrangements. If the PI selects a team composed solely of private industry and academia, then the contract with the PI will be developed, executed, and administered by GSFC. In the case where the PI chooses to team with a NASA Center, NASA may request the participating Center to develop and administer the contract(s). This may also occur in cases where a Center is supporting a mission in a reduced capacity. When a Center provides the procurement service, mission resources will be transferred to the Center using standard NASA funding processes. If the PI teams with an FFRDC, then GSFC could work with the FFRDC sponsor agency to establish a task order for the mission as part of the existing FFRDC contract. Funding would be transferred from NASA to the sponsoring Agency via an interagency funding transfer. The PI is expected to recommend, as part of his teaming arrangement, the organizations and mechanisms the Government should use in awarding work to his team.

Contracts for PI-Mode missions will require the approval of NASA, regardless of the procurement organization, prior to issuance to the contractor. Cost and performance incentive fee contracts are strongly encouraged, particularly where performance incentives are measured based on flight performance.

NASA will assure that the program and its missions are being conducted properly by empowering appropriate organizations to conduct oversight activities in relation to mission and contract execution. The level of oversight and the organizations responsible will vary, depending on which phase the program is in and the teaming arrangements. Product assurance, contract administration and cost, schedule, and technical oversight are the principal areas for oversight.

Reporting and review requirements will vary according to the phase of the mission. Missions in Phase B will have a kick-off meeting, provide a midterm report and submit required information for the Phase B final review. The midterm report and final review will cover cost, schedule, and technical status.

Missions in Phase C/D will be subject to one independent cost, schedule and technical review per year, typically tied to a major mission milestone (e.g., CDR). The

independent review board participants will be selected by NASA, and members could come from any private or Government concern. This review board will have the authority to make recommendations for continuance or termination of the project. In addition, if either the PI or GSFC determines that the mission cannot be completed within the agreed upon constraints, a termination review will be scheduled.

Missions will be expected to report progress on a periodic basis. Specific formats and reporting periods will be mutually defined by the Project and the PI. The scope of each report will vary by Phase but should contain cost, schedule and technical status. Generally, reports generated by the team for their own internal management reviews will be adequate to meet Government reporting requirements. The PI will be required to submit cost and obligation plans on an annual basis and to submit monthly reports of actual costs and obligations.

2. PROPOSAL INSTRUCTIONS

The proposer should first submit a Step-One Proposal, as outlined below. Based on the evaluation of Step-One Proposals, NASA will select a number of investigations for further consideration. Each of these investigations will then submit a Step-Two Proposal, with evaluation leading to selection of two primary and two alternate missions, as described in Section I.B of the body of this AO.

The guidelines for the Cover Letter, Table of Contents, Identifying Information, and Investigation Summary Form apply to both the Step-One and Step-Two Proposals. Guidelines specific to each proposal step follow.

Cover Letter

A letter or cover page should be forwarded with the proposal. It should be signed by the investigator and by an institutional official who is authorized to certify institutional support and sponsorship of the investigation and of the management of the proposal. It should also be signed by the authorizing official from each organization represented on the team who is authorized to commit that institution to the proposed investigation.

Table of Contents

The proposal should contain a table of contents.

Identifying Information

The proposal should contain a short descriptive title for the investigation; the names of all investigators; the names of all participating organizations or institutions; and the full name, address, and telephone number of the Principal Investigator (PI).

Investigation Summary Form

The salient features of the proposed investigation should be summarized in an "Investigation Summary Form," which is provided as Figure H-6 at the back of this Appendix. A figure or drawing of the instrument and/or spacecraft may be included at the proposer's discretion.

STEP-ONE PROPOSAL

1. SCIENCE INVESTIGATION AND INVESTIGATION PLAN

This section should address the following:

a. Summary. A concise statement describing the investigation, its conduct, and the anticipated results.

b. Objective and Significant Aspects. A brief definition of the objectives, their value, and their relationships to past, current, and future effort. The history and basis for the proposal, including demonstration of the need for such an investigation. A statement of present development in the discipline field.

c. Investigation Approach

   1. Fully describe the concept of the investigation.
   2. Detail the method and procedures for carrying out the investigation.

The above information will constitute the Baseline Mission. This section must also identify a minimum acceptable data and scientific return for the mission (the Minimum Science Mission), below which the mission would not be worth pursuing. Options for descoping the mission from the Baseline Mission to the Minimum Science Mission, and their impact to the investigation, should be briefly discussed. Proposals should include only one Baseline Mission and one Minimum Science Mission. NASA will not consider more than one Baseline Mission or Minimum Science Mission per proposal.

2. TECHNICAL APPROACH

The Technical Approach should describe the method and procedures for mission definition, design, development, integration, ground operations, and mission operations. This section should also describe the expected products and end items associated with each phase.

a. Mission Operations Concept and Requirements — This section should address the operational phase of the mission from launch to end of mission. The following elements should be addressed:

   1. Mission operations scenarios
   2. Spacecraft pointing requirements
   3. Attitude determination
   4. Orbit determination
   5. Communications requirements
   6. Mission lifetime
   7. Launch and/or operational (data collection) window(s)
   8. Orbital requirements
   9. Use of NASA ground system and operations functions and capabilities defined in Appendix C

b. Instrumentation — This section should describe the instrumentation and the criteria used for its selection. A description of the instrument, including layout and block diagrams, should be provided. The state of maturity of the instrument, including breadboards, prototypes, existing instrumentation, and heritage, should be described. Prior instrument investigation studies performed should be summarized. Instrument performance requirements should be related to the investigation goals and objectives for both the Baseline Mission and Minimum Science Mission as described in Section 1 above. A description of the technology/development risks and the plan to address them should be included. The following basic instrument information should be provided:

   1. size
   2. mass
   3. shape
   4. mechanical interface with the spacecraft
   5. field of view
   6. power consumption (nominal, peak, duty cycle, standby)
   7. basic functional description
   8. basic operational description

9. power interface

10. telemetry and command interface

c. Spacecraft — This section should describe the spacecraft design concept and requirements. The basis for the spacecraft concept, such as another spacecraft of known cost, should be provided. Required spacecraft resources should be described. A description of the payload layout and configuration should be included. Key features and sensitivities of the spacecraft, as they apply to the investigation, should be identified, including electrostatic discharge, magnetics, contamination, electromagnetic interference, etc.

3. DATA REDUCTION AND ANALYSIS PLAN

This plan should detail the method and format of the data reduction and analysis effort. A plan and schedule for distribution of reduced data to Co-investigators should be included. The plan should also include a schedule for the submission of reduced data to the National Space Science Data Center (NSSDC), Greenbelt, MD. Justification must be provided for the need for, and duration of, any proprietary rights for the PI for any data obtained as part of the mission's scientific investigation.

4. MANAGEMENT PLAN

This section should summarize the investigator's proposed management approach. The programmatic rationale and justification for carrying out the investigation using the PI-Mode management approach shall be described. The management organization and decision-making process should be described, teaming arrangements should be discussed, and responsibilities of team members and institutional commitments should be detailed. Unique capabilities that each member organization brings to the team, as well as previous experience with similar systems and equipment, should be addressed.

A top-level schedule for the definition and development phases should be provided. Key interdependencies, critical paths, and long lead procurements should be identified.

5. COST PLAN (U.S. INVESTIGATIONS ONLY)

The cost plan should summarize the total mission cost by major categories of cost. Top level costs should be provided for the definition, development, and operations

phases. Proposers should refer to the Work Breakdown Structure (WBS) in Figure H-3 for cost elements to be considered in developing the top level costs.

The cost plan should include the following:

a. Breakdown of development and operations costs into the following broad categories (including budget reserve for each category):
    1. Instrument
    2. Spacecraft
    3. Mission systems integration and test
    4. Operations preparations
    5. MO&DA
b. Definition phase cost for the following cases:
    1. 10-month definition phase
    2. 22-month extended definition phase
c. Alternate investigation funding for 1 or 2 years
d. Rationale for cost and budget reserve

STEP-TWO PROPOSAL

VOLUME I

INVESTIGATION AND TECHNICAL PLAN

1. SCIENCE INVESTIGATION AND INVESTIGATION PLAN

This section should only address changes to the Science Investigation and Investigation Plan from the Step-One Proposal. Any descoping of the investigation from the Baseline Mission defined in Step-One should be identified.

2. TECHNICAL APPROACH

The Technical Approach section should detail the method and procedures for mission definition, design, development, manufacturing, integration and test, ground operations, and mission operations. This section should also detail the expected products and end items associated with each phase. Mission teams have the freedom to use their own processes, procedures, and methods. The use of innovative

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processes, techniques, and activities by mission teams in accomplishing their objectives is encouraged when cost, schedule, and technical improvements can be demonstrated. The experience and qualifications of performing organizations should by discussed.

This section must be complete in itself without the need to request additional data. Failure to furnish complete data may preclude evaluation of the proposal.

a. Mission Design — This section should fully describe the operational phase of the mission from launch to end of mission. The following mission elements should be addressed:

   1. Mission operations scenarios — preliminary mission timeline covering typical science operations scenarios indicating periods of acquisition, data downlink, etc.,
   2. Spacecraft pointing requirements:
      - where, when, which axis
      - accuracy
      - stability
      - special requests (maneuvers, Sun/Moon/Earth avoidance, etc.)
   3. Attitude determination
      - when
      - stability/accuracy
   4. Orbit determination — in-track, across-track, altitude, frequency
   5. Communications requirements — facilities, data rates, bit error rate, etc.
   6. Mission lifetime
   7. Launch and/or operational (data collection) window(s)
      - science related
      - other
   8. Orbital requirements:
      - required
      - desired
      - constraints (SAA avoidance, etc.)

b. Instrumentation — This section should fully describe the instrumentation and the criteria used for its selection. It should indicate items that are proposed to be developed, as well as any existing instrumentation or design heritage. Particular attention should be paid to describing any required technology development, the risks involved, and alternative approaches. Performance characteristics of the

instrumentation should be related to the measurement and investigation objectives as stated in the Section 1, for both the Baseline Mission and the Minimum Science Mission. The following basic instrument information should be included:

1. size
2. mass
3. center of gravity
4. shape
5. mechanical interface with the spacecraft
6. thermal paths
7. field of view
8. power consumption (nominal, peak, duty cycle, standby)
9. basic functional description
10. basic operational description
11. power interface
12. telemetry and command interface

c. Spacecraft — This section should describe the spacecraft design approach, particularly as it relates to new versus existing hardware and redundant versus single-string hardware. It should fully identify the spacecraft and describe its characteristics and requirements. A preliminary description of the spacecraft design with a block diagram showing the spacecraft subsystems and their interfaces should be included, along with a description of the flight software and a summary of the estimated performance of the spacecraft. The flight heritage or rationale used to select the spacecraft and its subsystems, major assemblies, and interfaces should be described.

Subsystem characteristics and requirements should be described to the extent possible. Such characteristics include: mass, volume, and power requirements; pointing knowledge and accuracy; new developments needed; flight qualification plan; and logistics support. These subsystems may include: structural/mechanical, solar array/power system (and batteries), electrical, thermal control, propulsion, communications, attitude control, command and data handling, etc. Adequate margins should be identified. Any design features incorporated to effect cost savings should be identified. A summary of the resource elements of the spacecraft design concept, including key margins, should be provided. The rationale for margin allocation should be provided. Those design margins that are driving costs should be identified.

Plans for all phases of software development or use of existing software (including "commercial off-the-shelf") should be described. The method planned for development and validation of flight software, and the

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method for resolving any major open spacecraft issues, major systems trades, and technology development planned to be addressed in Phase B should be addressed. A preliminary schedule for the spacecraft development should be included. Along with a description of the payload layout and configuration, this section should address accommodation of the instrumentation by the spacecraft as follows:

1. preferred launch orientation
2. instrument location constraints:
   - relative to other instruments
   - relative to spacecraft components
3. alignment to axis
4. baffling or other protection
5. thermal environment/temperature limits:
   - operational
   - survival
6. data processing (onboard and on the ground)
7. telemetry — type, quantity, sample rate, time tagging, format
8. commands — type, quantity, function, timing constraints, frequency
9. timing (clocks) — resolution, accuracy, transfer method
10. environmental sensitivities — electrical cleanliness, magnetic fields, contamination
11. data collection and storage — volume, frequency, speed/rate, bit error rate
12. required U.S. Government support — Government furnished equipment, services, facilities

d. Manufacturing, Integration, and Test — This section should describe the manufacturing strategy to produce and test the hardware/software necessary to accomplish the mission. It should include a description of the main processes/procedures planned in the fabrication of flight hardware, software, transitioning from design to production, production personnel resources, incorporation of new technology/materials, and the preliminary test and verification program.

The approach, techniques, and facilities planned for integration, test and verification, and launch operations phases, consistent with the proposed schedule and cost, should be described. A preliminary schedule for manufacturing, integration, and test activities should be included. A description of the planned end items, including engineering and qualification hardware, should be included. The use of any existing test facilities and processes should be described.

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e. Mission Operations — This section should identify requirements for mission operations support including mission planning. Requirements should be referenced to the baseline functions and capabilities defined in Appendix C. Requests for enhancements beyond the baseline should be specifically identified. Special communications facilities that are needed must be described. Any special orbital requirements, such as time of month, time of day, phase of moon, and lighting conditions are to be given in detail. Describe real-time ground support requirements and indicate any special equipment or skills required of ground personnel.

f. Ground and Data Systems — This section should discuss the ground operations support required for the proposed investigation. Requirements should be referenced to the baseline functions and capabilities defined in Appendix C. Requests for enhancements beyond the baseline should be specifically identified. The approach to the development of the ground and data system (GDS), including the use, if any, of existing facilities should be described. Details of communications needs, tracking needs, and special techniques should be delineated. Describe the communications facilities that will be used, including any NASA facilities or special facilities. All usage of NASA communication facilities should be explicitly described. Any mission-unique facilities must be adequately described. Describe all communications, tracking, and ground support requirements. Describe the software development approach and its relationship to the spacecraft software development.

g. Performance Assurance — This section should contain the approach to performance assurance as described in Appendix D.

h. New Technology and Technology Transfer — This section should describe those technologies to be considered for potential application to the mission and their rationale. The methods by which these new technologies will be assessed and their risks reduced, as well as the means to validate these technologies, should be described. The potential for transfer of new technology from this mission to other applications in NASA, the Federal Government, and/or in the private sector should be described. Alternative approaches to the use of these new technologies should be identified.

3. DATA REDUCTION AND ANALYSIS PLAN

This section should only address changes to the Data Reduction and Analysis Plan from the Step-One Proposal.

VOLUME II

MANAGEMENT PLAN

The Management Plan should describe the management approach and the facilities and equipment required. The plan shall include the programmatic rationale and justification for carrying out the investigation using the PI-Mode management approach. This section sets forth the investigator's approach for managing the work, the recognition of essential management functions, and the overall integration of these functions. This section should specifically discuss the decision-making process to be used by the team, focusing particularly on the roles of the Principal Investigator and Project Manager in that process. The management plan gives insight into the organizations proposed for the work, including the internal operations and lines of authority with delegations, together with internal interfaces and relationships with NASA, major subcontractors, and associated investigators. It also identifies the institutional commitment of all team members, and the institutional roles and responsibilities. The use of innovative processes, techniques, and activities by mission teams in accomplishing their objectives is encouraged when cost, schedule, and technical improvements can be demonstrated.

a. Management Processes and Plans, Schedule, and Procurement Strategy — This section should describe the management processes and plans, schedules, and procurement strategy necessary for the logical and timely pursuit of the work, accompanied by a description of the work plan. This section should also describe the proposed methods of hardware and software acquisition. Specifically, it should include the following, as applicable:

   1. Unique or proprietary capabilities that each member organization brings to the team, as well as previous experience with similar systems and equipment.

   2. Management processes which the investigator team proposes to:

      a. develop and maintain the hardware and software requirements and specifications;

      b. manage and control development progress;

      c. manage and conduct technology development;

      d. manage and conduct design;

      e. manage, review, and control hardware/software, documentation, etc. changes;

      f. manage and conduct systems engineering and integration;

      g. manage and conduct procurement including make or buy

decisions, subcontract management, etc.;

h. manage and conduct the testing and verification programs, including final checkout and calibration;

i. assure safety, reliability, and quality;

j. manage and conduct launch and mission operations;

k. manage and conduct data reduction, analysis, and archiving;

l. coordinate with team members and document agreements;

m. manage and control finances within cost limitations;

n. report progress to NASA.

3. Rationale for the investigator to obtain the spacecraft through or by the investigator's institution.

4. Method and basis for the selection of the proposed spacecraft fabricator, including contract type and rationale.

5. Availability of supporting personnel in the institution to successfully administer the spacecraft contract and technically monitor the design, development, and test.

6. Development status of the spacecraft, including areas requiring further design or development or in which unknowns are present.

7. The specific decision-making process regarding all aspects of the mission, including mission descoping, and the individual with ultimate decision-making authority in such cases.

8. Availability of proposed personnel on the team to successfully administer the investigation contract and technically monitor the implementation.

The schedule and work flow should be clearly laid out, and the method for internal review, control, and direction discussed, including whether or not a form of performance measurement system will be used.

b. Roles, Responsibilities, and Experience of Team Members — The roles, responsibilities, time commitment, and experience of all key personnel must be described in this section, with particular emphasis placed on the responsibilities assigned to the PI and the Project Manager. In addition, information should be provided which indicates what percentage of time will be devoted to the mission, the duration of service, and how changes in personnel will be accomplished.

1. Principal Investigator. The role(s), responsibilities, and time commitment of the Principal Investigator should be discussed here.

2. Project Manager. The role, responsibilities, time commitment, and experience of the Project Manager should be discussed in this section.

3. Other Key Personnel. The roles, responsibilities, time commitments, and experience of the Co-Investigators and other key

personnel in the investigation should be described in this section.

The management structure of the mission team must be described in the proposal. The proposal must identify the teaming approach to be used and describe the responsibilities of each team member and their contributions to the mission.

Financial responsibilities of all team partners must be described. The mechanisms (contracts, subcontracts, cooperative agreements, memoranda of agreement, letters of endorsement, etc.) by which organizations commit to participate as partners on a proposing team must be clearly identified. Include a description of the fee strategy, where appropriate, and the rationale. The proposal signature page must include the signature of an official from each organization represented on the team or contributing to the mission who is authorized to commit that organization to the proposed mission. Failure to include any such authorization may be grounds for rejection of the proposal. Non-U.S. organizations participating as team partners must also meet this requirement.

Any experience (successes and failures) of team partners in meeting cost and schedule constraints in similar projects within the last ten years should be discussed.

c. Risk Management and Descope Options — This section should describe the approach to risk management to be taken by the team. Particular emphasis should be placed on describing how the various elements of risk will be managed to ensure successful accomplishment of the investigation within cost and schedule constraints. In the event risks cannot be managed successfully and mission objectives must be revised toward the Minimum Science Mission, then this section should briefly describe the descope options available, their phasing, and their effect on mission performance relative to the previously defined Minimum Science Mission. This section should identify the latest possible dates at which descope options may be implemented and the procedure by which they would be accomplished.

d. Facilities and Equipment — All major facilities, laboratory equipment, and ground-support equipment (GSE) (including those of the team's proposed contractors and those of NASA and other U.S. Government agencies) essential to the mission in terms of its system and subsystems are to be indicated, distinguishing insofar as possible between those already in existence and those that will be developed in order to execute the mission. The outline of new facilities and equipment should also indicate the lead time involved and the planned schedule for construction, modification, and/or acquisition of the facilities.

e. Educational and Public Outreach — This section should discuss the degree to which this mission will generate educational opportunities and contribute to the Nation's educational initiatives. The involvement of teachers and/or students in the mission should be documented here, as

should any educational activities to be implemented. Coordination and collaboration with educational institutions should be discussed. Activities to enhance the level of understanding and awareness of space science by the public should be described.

f. Small and Small Disadvantaged Businesses — This section should describe the opportunities offered by the mission for small and small disadvantaged businesses. It should also describe the breadth of participation in the mission by members of the industry, academic, not-for-profit, and Federal communities, as well as discussing the opportunities offered by the mission for other members of these communities. This section should identify the percentage of work, expressed as percentage of total subcontract cost/price and total contract cost/price, to be performed by small businesses (SB's) and small disadvantaged businesses (SDB's). Goals for SB and SDB subcontracting are contained in Appendix E.

VOLUME III

COST PLAN (U.S. Investigations Only)

The cost plan should summarize the total mission cost by major categories of cost as well as by function. The plan should address the definition, development, and operations phases.

1. The categories of cost should include the following:
   a. Direct Labor. List by labor category, with labor hours and rates for each. Provide actual salaries of all personnel and the percentage of time each individual will devote to the effort.
   b. Overhead. Include indirect cost, which because of its incurrence for common or joint objectives, is not readily subject to treatment as a direct cost. Usually this is in the form of a percentage of the direct labor costs.
   c. Materials. This should give the total cost of the bill of materials including estimated cost of each major item. Include lead time of critical items.
   d. Subcontracts. List those over $25,000, specify the vendor and the basis for estimated cost. Include any baseline or supporting studies.
   e. Other Costs. Costs not covered elsewhere.
   f. General and Administrative Expense. This includes the expenses of the institution's general and executive offices and other miscellaneous expenses related to the overall business.
   g. Fee (if applicable).

2. Separate schedules summarizing cost by category and phase (in the format shown in Figures H-1 and H-2) should be provided for each functional element of the mission, as defined by the proposer's Work Breakdown Structure (WBS). A reference WBS for a PI-Mode mission is included as Figure H-3. Costs should be presented at level 2 of the WBS (i.e., 1.0 Management; 2.0 Science Support; etc.) except where significant development work is included (e.g., 4.0 Instruments; or 5.0 Spacecraft). In these areas, costs should be allocated and presented to the subsystem level (e.g., 5.3.1 Spacecraft Attitude Control), and a rationale for the estimate should be included. Costs should be presented in FY 1994 dollars. A NASA inflation index is included as Figure H-4. These rates will be used to convert FY 1994 dollars to bid rates unless the proposing organization has formally negotiated other rates. If this is the case, the negotiated rates should be provided in Figures H-1 and H-2.

3. Separate and complete cost plans are required for the case of a 10-month definition phase as well as a 22-month definition phase, as shown in Figures H-1 and H-2. Note that for the 22-month definition phase, funding for the first year is limited to $500,000. In addition, proposers shall complete a Standard Form (SF) 1411, included as Figure H-5, for Phases I and II.

4. Proposers shall also separately propose costs necessary to cover 1 or 2 years of effort to maintain a nucleus of the investigation team, if selected as an alternate investigation.

SUMMARY OF ELEMENTS OF COST
(FY94 DOLLARS)

	PHASE I	PHASE II	PHASE III			TOTAL	PHASE IV			
	10-MONTH DEFINITION	3-MONTH INITIAL DESIGN AND DEVELOPMENT	DESIGN, DEVELOPMENT & OPS (LAUNCH + 30 DAYS)			DEF., DESIGN & DEVEL.	MO&DA (BEGINS 31 DAYS AFTER LAUNCH)			
			YEAR 1*	YEAR 2	YEAR3		YEAR 1	YEAR 2	YEAR3	TOTAL
DIRECT LABOR										
HOURS (BY LABOR CATEGORIES)										
COSTS (BY LABOR CATEGORIES)										
OVERHEAD ($/%)										
OTHER DIRECT COSTS										
SUBCONTRACTS**										
MATERIALS										
OTHER										
TOTAL ODC										
SUBTOTAL										
G&A ($/%)										
TOTAL COST										
FEE ($/%)										
TOTAL FY94$										
INFLATION FACTOR										

* COVERS A 9 MONTH PERIOD, I.E., PHASES II & III TOTAL 36 MONTHS

** FOR SUBCONTRACTS OVER $25,000, THE CONTRACTOR WILL PROVIDE THE SAME DETAILS AS IN THEIR OWN PROPOSAL.

FIGURE H-1 SUMMARY OF ELEMENTS OF COST

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SUMMARY OF ELEMENTS OF COST
(FY94 DOLLARS)

	PHASE I 22-MONTH DEFINITION YEAR1	PHASE I YEAR2	PHASE II 3-MONTH INITIAL DESIGN AND DEVELOPMENT	PHASE III DESIGN, DEVELOPMENT & OPS (LAUNCH + 30 DAYS) YEAR 1*	PHASE III YEAR 2	PHASE III YEAR3	TOTAL DEF., DESIGN & DEVEL.	PHASE IV MO&DA (BEGINS 31 DAYS AFTER LAUNCH) YEAR 1	PHASE IV YEAR 2	PHASE IV YEAR3	PHASE IV TOTAL
DIRECT LABOR											
HOURS (BY LABOR CATEGORIES)											
COSTS (BY LABOR CATEGORIES)											
OVERHEAD ($/%)											
OTHER DIRECT COSTS											
SUBCONTRACTS**											
MATERIALS											
OTHER											
TOTAL ODC											
SUBTOTAL											
G&A ($/%)											
TOTAL COST											
FEE ($/%)											
TOTAL FY94$											
INFLATION FACTOR											

* COVERS A 9 MONTH PERIOD, I.E., PHASES II & III TOTAL 36 MONTHS

** FOR SUBCONTRACTS OVER $25,000, THE CONTRACTOR WILL PROVIDE THE SAME DETAILS AS IN THEIR OWN PROPOSAL.

FIGURE H-2 SUMMARY OF ELEMENTS OF COST (EXTENDED DEF.)

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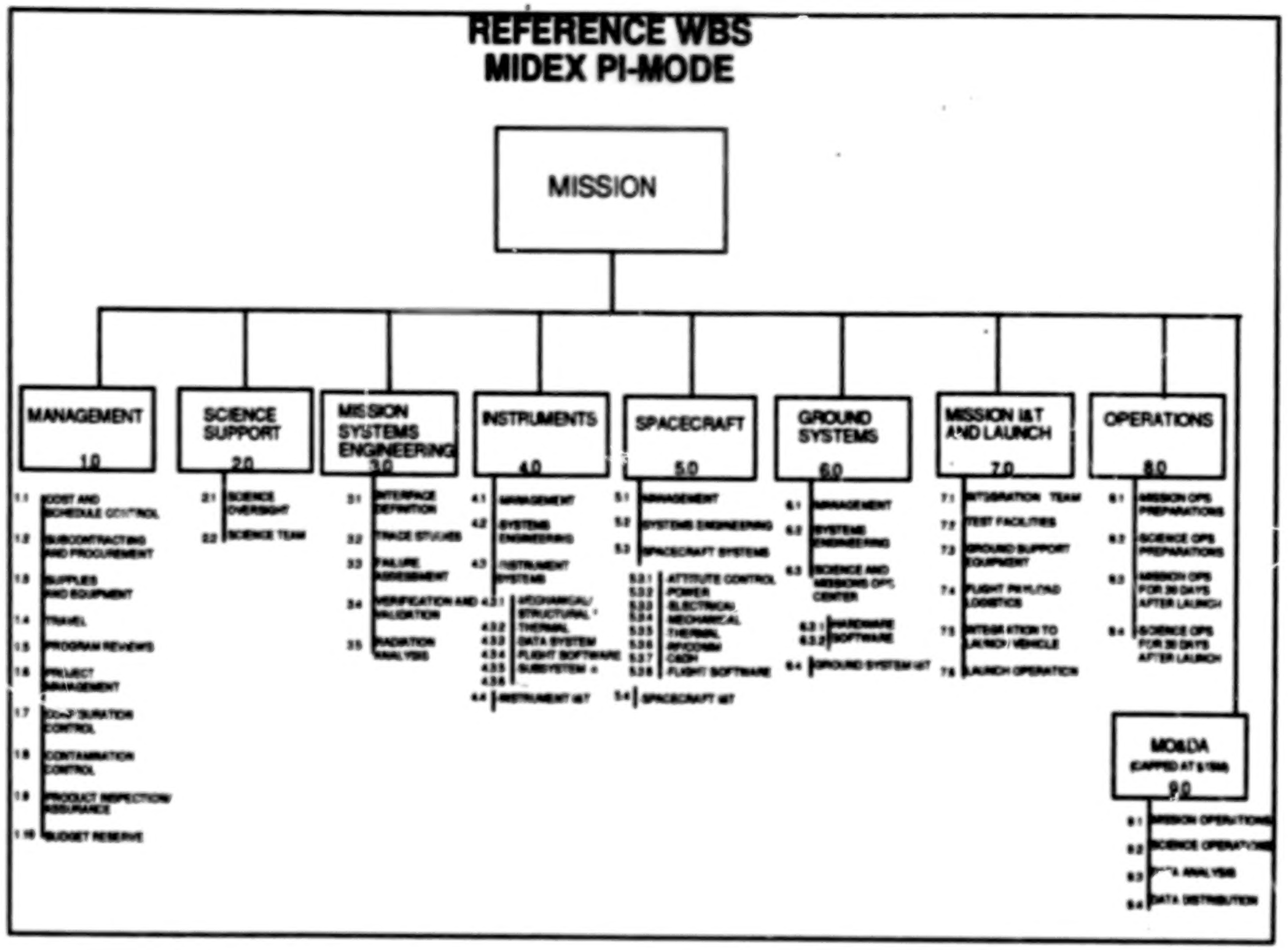

FIGURE H-3 REFERENCE WBS

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Fiscal Year	Inflation Rate
FY 1995	4.7%
FY 1996	4.5%
FY 1997	5.1%
FY 1998	5.1%
FY 1999	4.7%
FY 2000	4.4%
FY 2001	4.4%
FY 2002	4.4%
FY 2003 and Outyears	4.6%

FIGURE H-4 NASA INFLATION INDEX

CONTRACT PRICING PROPOSAL COVER SHEET

1. SOLICITATION/CONTRACT/MODIFICATION NO.

FORM APPROVED OMB NO. 9000-0013

NOTE: This form is used in contract actions if submission of cost or pricing data is required. (See FAR 15.804-6(b))

2. NAME AND ADDRESS OF OFFEROR (Include ZIP Code)

3A. NAME AND TITLE OF OFFEROR'S POINT OF CONTACT

3B. TELEPHONE NO.

4. TYPE OF CONTRACT ACTION (Check)

☐	A. NEW CONTRACT	☐	D. LETTER CONTRACT
☐	B. CHANGE ORDER	☐	E. UNPRICED ORDER
☐	C. PRICE REVISION/ REDETERMINATION	☐	F. OTHER (Specify)

5. TYPE OF CONTRACT (Check)

☐ FFP ☐ CPFF ☐ CPIF ☐ CPAF
☐ FPI ☐ OTHER (Specify)

6. PROPOSED COST (A+B=C)

A. COST	B. PROFIT/FEE	C. TOTAL
$	$	$

7. PLACE(S) AND PERIOD(S) OF PERFORMANCE

8. List and reference the identification, quantity and total price proposed for each contract line item. A line item cost breakdown supporting this recap is required unless otherwise specified by the Contracting Officer. (Continue on reverse, and then on plain paper, if necessary. use same headings.)

A. LINE ITEM NO.	B. IDENTIFICATION	C. QUANTITY	D. TOTAL PRICE	E. REF.

9. PROVIDE NAME, ADDRESS, AND TELEPHONE NUMBER FOR THE FOLLOWING (If available)

A. CONTRACT ADMINISTRATION OFFICE

B. AUDIT OFFICE

10. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS WORK? (If "yes," identify)

☐ YES ☐ NO

11A. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT? (If "Yes," complete Item 11B)

☐ YES ☐ NO

11B. TYPE OF FINANCING (✓ one)

☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS
☐ GUARANTEED LOANS

12. HAVE YOU BEEN AWARDED ANY CONTRACTS OR SUBCONTRACTS FOR THE SAME OR SIMILAR ITEMS WITHIN THE PAST 3 YEARS? (If "Yes," identify item(s), customer(s) and contract number(s))

☐ YES ☐ NO

13. IS THIS PROPOSAL CONSISTENT WITH YOUR ESTABLISHED ESTIMATING AND ACCOUNTING PRACTICES AND PROCEDURES AND FAR PART 31, COST PRINCIPLES? (If "No," explain)

☐ YES ☐ NO

14. COST ACCOUNTING STANDARDS BOARD (CASB) DATA (Public Law 91-379 as amended and FAR PART 30)

A. WILL THIS CONTRACT ACTION BE SUBJECT TO CASB REGULATIONS? (If "No," explain in proposal)

☐ YES ☐ NO

B. HAVE YOU SUBMITTED A CASB DISCLOSURE STATEMENT (CASB DS-1 or 2)? (If "Yes," specify in proposal the office to which submitted and if determined to be adequate)

☐ YES ☐ NO

C. HAVE YOU BEEN NOTIFIED THAT YOU ARE OR MAY BE IN NON-COMPLIANCE WITH YOUR DISCLOSURE STATEMENT OR COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)

☐ YES ☐ NO

D. IS ANY ASPECT OF THIS PROPOSAL INCONSISTENT WITH YOUR DISCLOSED PRACTICES OR APPLICABLE COST ACCOUNTING STANDARDS? (If "Yes," explain in proposal)

☐ YES ☐ NO

This proposal is submitted in response to the RFP, contract, modification, etc. in Item 1 and reflects our best estimates and/or actual costs as of this date and conforms with the instructions in FAR 15.804-6(b) (2), Table 15-2. By submitting this proposal, the offeror, if selected for negotiation, grants the contracting officer or an authorized representative the right to examine, at any time before award, those books, records, documents and other types of factual information, regardless of form or whether such supporting information is specifically referenced or included in the proposal as the basis for pricing, that will permit an adequate evaluation of the proposed price.

15. NAME AND TITLE (Type)

16. NAME OF FIRM

17. SIGNATURE

18. DATE OF SUBMISSION

NSN 7540-01-142-9845 7/87 edition is usable. EXPIRATION DATE 7-31-93 1411-103 STANDARD FORM 1411 (REV. 2-91) Prescribed by GSA - FAR (48 CFR) 53.215-2(a)

* U.S Government Printing Office 1992- 322-340/60057

FIGURE H-5 SF 1411 (CONTRACT PRICING PROPOSAL COVER SHEET)

PROPOSAL #
NASA USE ONLY

Medium - Class Explorer (MIDEX)
Investigation Summary Form

PRINCIPAL INVESTIGATOR			
INSTITUTION			
DEPARTMENT			
ADDRESS / STREET			
CITY / TOWN	STATE	ZIP / POSTAL CODE	COUNTRY
TELEPHONE	FAX	E-MAIL ADDRESS	

INVESTIGATION TITLE
INVESTIGATION ABSTRACT (LIMIT 150 WORDS)

DISCIPLINE AREA (CHECK AS APPLY)

[ ] SPACE PHYSICS
- [ ] IONOSPHERIC [ ] MESOSPHERIC
- [ ] THERMOSPHERIC [ ] COSMIC
- [ ] MAGNETOSPHERIC
- [ ] HELIOSPHERIC [ ] SOLAR

[ ] ASTROPHYSICS
- [ ] RADIO [ ] INFRARED
- [ ] SUBMILLIMETER [ ] OPTICAL
- [ ] ULTRAVIOLET [ ] X-RAY
- [ ] GAMMA-RAY [ ] GRAVITY

SPACECRAFT MODE (CHECK ONE)
- [ ] NASA-PROVIDED
- [ ] PI-MODE

TOTAL BUDGET AMOUNT (EXCLUDING MO&DA)	TOTAL MO & DA BUDGET
$ ____________________	$ ______________

FIGURE H-6 INVESTIGATION SUMMARY FORM

PROPOSAL #
NASA USE ONLY

PRINCIPAL INVESTIGATOR
INVESTIGATION TITLE

LIST OF CO-INVESTIGATORS

NAME	INSTITUTION

INSTITUTIONAL ENDORSEMENT

INSTITUTION NAME	
NAME AND TITLE OF AUTHORIZING OFFICIAL	
SIGNATURE	DATE

FIGURE H-6 (CONT.) INVESTIGATION SUMMARY FORM

APPENDIX I

MIDEX AO Reference Documents Available from the Explorers Project Library

1. Guidelines for Acquisition of Investigations (NHB 8030.6B)

2. NASA Office of Space Science (OSS) Integrated Technology Strategy

3. Military Standard Aircraft Internal Time Division Command/Response Multiplex Data Bus (MIL-STD-1553B)

4. Fiber Optic Mechanization of an Aircraft Internal Time Division Command/Response Multiplex Data Bus (MIL-STD-1773)

5. Medium Explorer (MIDEX) Program Performance Assurance Requirements

6. Consultative Committee for Space Data Systems (CCSDS) Report Concerning Space Data System Standards
   a. Telecommand — Summary of Concept and Rationale (CCSDS 200.0-G-6)
   b. Telemetry — Summary of Concept and Rationale (CCSDS 100.0-G-1)

7. Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing (ANSI/ASQC Q9001-1994)

8. Sample Contract Schedules for Cost-Reimbursement Phase B and Phase C/D Instrument Contracts

9. Sample Contract Schedules for Cost-Reimbursement Phase B and Phase C/D Mission Contracts

10. Sample Contract for Firm-Fixed Price Spacecraft Contract

11. Management of Major System Programs and Projects (NHB 7120.5)

12. The Medium Explorers Ground System Capabilities Document

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APPENDIX J

MIDEX AO ACRONYMS

A	Ampere
A-Hr	Ampere-Hour
ACE	Advanced Composition Explorer
ACE	Attitude Control Electronics
ACS	Attitude Control System
ANSI	American National Standards Institute
AO	Announcement of Opportunity
AOS	Advanced Orbiting System
ASQC	American Society of Quality Control
C&DH	Command and Data Handling
CCD	Charge Coupled Device
CCSDS	Consultative Committee on Space Data Systems
CDR	Critical Design Review
CG	Center of Gravity
cm	centimeter
CPFF	Cost Plus Fixed Fee
CSS	Coarse Sun Sensor
dB	decibel
DPU	Data Processing Unit
DSN	Deep Space Network
DSS	Digital Sun Sensor
ELV	Expendable Launch Vehicle
EOL	End of Life
FAR	Federal Acquisition Regulation
FAST	Fast Auroral Snapshot Explorer
FFP	Firm Fixed Price
FFRDC	Federally Funded Research and Development Center

FUSE	Far Ultraviolet Spectroscopic Explorer
FY	Fiscal Year
G&A	General and Administrative
GaAs	Gallium Arsenide
GDS	Ground and Data System
GN	Ground Network
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
Hz	Hertz
IRD	International Relations Division
kbps	kilobits per second
kg	kilogram
km	kilometer
LAN	Local Area Network
LEO	Low Earth Orbit
m	meter
Mbps	Megabits per second
MIDEX	Medium Explorers
MIL-STD	Military Standard
mm	millimeter
MO&DA	Mission Operations and Data Analysis
MOC	Mission Operations Center
MUE	Mission Unique Electronics
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NFS	NASA FAR Supplement
NHB	NASA Handbook
NiCd	Nickel Cadmium
NSSDC	National Space Science Data Center
ODC	Other Direct Charges
OFCC	Office of Federal Contract Compliance
OSAT	Office of Space Access and Technology

OSS	Office of Space Science
PAR	Performance Assurance Requirements
PI	Principal Investigator
PM	Project Manager
PSE	Power System Electronics
QA	Quality Assurance
RF	Radio Frequency
RFP	Request for Proposal
rpm	revolutions per minute
SAA	South Atlantic Anomaly
SAMPEX	Solar, Anomalous, and Magnetospheric Particle Explorer
SB	Small Business
SDB	Small Disadvantaged Business
SF	Standard Form
SMEX	Small Explorer
SOC	Science Operations Center
SWAS	Submillimeter Wave Astronomy Satellite
TCP/IP	Transmission Control Protocol/Internet Protocol
TDRSS	Tracking and Data Relay Satellite System
TOTS	Transportable Orbital Tracking Station
TRACE	Transition Region and Coronal Explorer
U.S.	United States
UNEX	University Explorers
V	Volts
W	Watts
WBS	Work Breakdown Structure
WFF	Wallops Flight Facility
WIRE	Wide-Field Infrared Explorer
XTE	X-Ray Timing Explorer

APPENDIX K

REQUIRED CERTIFICATION FORMS

CERTIFICATION REGARDING LOBBYING

CERTIFICATION REGARDING DRUG-FREE WORKPLACE REQUIREMENTS

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS PRIMARY COVERED TRANSACTIONS

CERTIFICATION REGARDING LOBBYING

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over $100,000, the applicant certifies that:

(a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Organization Name　　　　AO or NRA Number and Title

Printed Name and Title of Authorized Representative

Signature　　　　Date

Printed Principal Investigator Name　　　　Proposal Title

CERTIFICATION REGARDING DRUG-FREE WORKPLACE REQUIREMENTS

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government-wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

I. GRANTEES OTHER THAN INDIVIDUALS

A. The grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about --

(1) The dangers of drug abuse in the workplace;

(2) The grantees policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will

(1) Abide by the terms of the statement; and

(2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d) (2) from an employee or otherwise receiving actual notice of such conviction;

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d) (2), with respect to any employee who is so convicted --

(1) Taking appropriate personnel action against such an employee, up to and including termination; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or Local health, Law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e), and (f)

B. The grantee shall insert in the space provided below the site(s) for the performance or work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

____

____

____

____

Check _____ if there are workplaces on file that are not identified here.

II. GRANTEES WHO ARE INDIVIDUALS

The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance in conducting any activity with the grant.

Organization Name	AO or NRA Number and Title
Printed Name and Title of Authorized Representative	
Signature	Date
Printed Principal Investigator Nam	Proposal Title

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participants' responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160–19211). Copies of the regulations may be obtained by contacting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, D.C. 20202-4725, telephone (202) 732-2505.

A. The applicant certifies that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification;

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

(a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department of agency.

(b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name | AO or NRA Number and Title

Printed Name and Title of Authorized Representative

Signature | Date

Printed Principal Investigator Name | Proposal Title

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- ☐ 9. Small Business

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- ☐ A. American Astronomical Society
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1. Astronomy and Astrophysics

- ☐ A. Theory and Modeling
- ☐ B. Instrumentation (Technology Dev)
- ☐ C. Laboratory Astrophysics
- ☐ D. Data Analysis (Archival)
- ☐ E. Observational Programs

2. Solar System Exploration

- ☐ A. Planetary Atmospheres and Astronomy
- ☐ B. Planetary Materials and Geochemistry
- ☐ C. Planetary Geology and Geophysics
- ☐ D. Instrument Development
- ☐ E. Origins of Solar Systems
- ☐ F. Exobiology

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- ☐ A. Cosmic and Heliosphere Physics
- ☐ B. Solar Physics
- ☐ C. Magnetospheric Physics
- ☐ D. Iono-Thermo-Mesospheric Physics

4. Information Systems/Computer Science

- ☐ A. High Performance Computing and Networking
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- ☐ C. Science Data Storage and Management
- ☐ D. Software Technology

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